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Land Use Differentiation in Sydney, Australia

CLIFFORD M. ZIERER

Sydney is primarily a port, but it is also an important manufacturing city, an administrative center, a capital, and an outstanding residential node. As the oldest and largest city in Australia it exerts a dominant influence on the economic, social, and political life of that continent. It marks the focus for many forms of human endeavor throughout the vast reaches of Australia and Oceania.

It is the purpose of the following discussion to differentiate and explain the major divisions of Sydney's general urban land use pattern. There is close accordance between the principal functional divisions of the city and its harbor which affords exceptional advantages not only for commerce and industry but also for residence and recreation. The names Port Jackson and Sydney Harbor are synonymous.¹

ORIGIN OF SYDNEY

Following the conclusion of the American War of Independence, England became seriously interested in Australia, which land had been claimed since the brief exploratory visit of James Cook in 1770. First there was the problem of relocating the Loyalists who eventually went to Eastern

¹ A brief discussion of the varied aspects of Sydney's geography is contained in J. Macdonald Holmes: "Geographic Factors in the Economy of Sydney," *Handbook for New South Wales*; Australian and New Zealand Association for the Advancement of Science (Sydney) 1932, pp. 39-56.

Canada or returned to England. Likewise the closing of the American colonies to the outflow of human material from English prisons created serious congestion in those institutions. When the suggestion was made that offenders of the law be dispatched to other distant parts of the empire, the thoughts of certain administrators turned logically to Botany Bay which had been so favorably reported upon by Cook's expedition. That proposal, however, was made only after authorities were convinced that transportation of prisoners to the coast of West Africa (Gambia) amounted practically to a death penalty.

Glowing accounts of parts of Australia by members of Cook's expedition, and the inviting character of the name "Botany Bay" itself, finally led to a decision in 1786 to send out the First Fleet. Arthur Phillip was placed in command of the expedition, which included eleven ships carrying 1,482 persons, of whom 778 were convicts and the remainder crew members and soldiers. The expedition reached Botany Bay in January, 1788, after a voyage occupying eight months. Brief stops were made at Rio de Janeiro and South Africa, at which points provisions and supplies were loaded.²

Arriving at Botany Bay, Phillip was not impressed with the reported advantages of the site even for a convict station (Fig. 1). He found the bay so shallow that his small vessels were obliged to lie opposite the entrance, where they were exposed to easterly blows. The water supply seemed inadequate; the soils were sandy and unpromising for agriculture; "fine meadows" were not in evidence; and the swampy character of the bay margins gave prospect of unhealthful conditions. It appeared that the botanical attractions of the vicinity had aroused too great enthusiasm on the part of certain members of Cook's expedition as to settlement possibilities.³

Within a few days it was decided to explore a break in the coast-line a few miles to the north, to which Cook had given the name Port Jackson, but which he had not entered in his northward passage from Cape Howe to Torres Strait. Upon entering the estuary, Phillip, who was in charge of the reconnaissance party, immediately declared it to be "the finest harbour in the world in which a thousand sail of the line might ride in the most perfect safety."⁴ An examination of the numerous coves was then under-

² Jenks, Edward: *A History of the Australian Colonies*; (Cambridge) 1896, p. 28.

³ Cook spent only a week in Botany Bay, which he entered primarily to secure fresh water. A small supply was found at Cook's Point on the sandy peninsula a short distance south of the entrance, where the initial landing was made (Fig. 1). The borders of the bay were explored as members of the scientific staff collected specimens of plant life for classification. Wood, G. A.: *The Discovery of Australia*; (London) 1922, pp. 423-5.

⁴ Quoted from a letter from Governor Phillip to Lord Sydney dated May 15, 1788, at Sydney Cove. *Historical Records of Australia*, Vol. I, pp. 9-32.



FIG. 1.—General location map to show the relation of Sydney and its many local municipalities to Port Jackson and other coastal indentations. The principal state railway and highway routes converge upon the central city. A portion of the metropolitan water supply system is shown in the southwest. The southernmost reaches of Broken Bay may be seen along the north margin of the map.

taken; whereupon, a small indentation, five miles from the entrance and on the south side of the embayment, was selected as the site for occupation (Fig. 2). Sydney Cove was preferred to other indentations principally because it had the finest stream, and deep water lay along shore enabling large vessels to discharge cargo easily. The moderate elevation of bordering shorelands and the close proximity of small tracts of potential agricultural

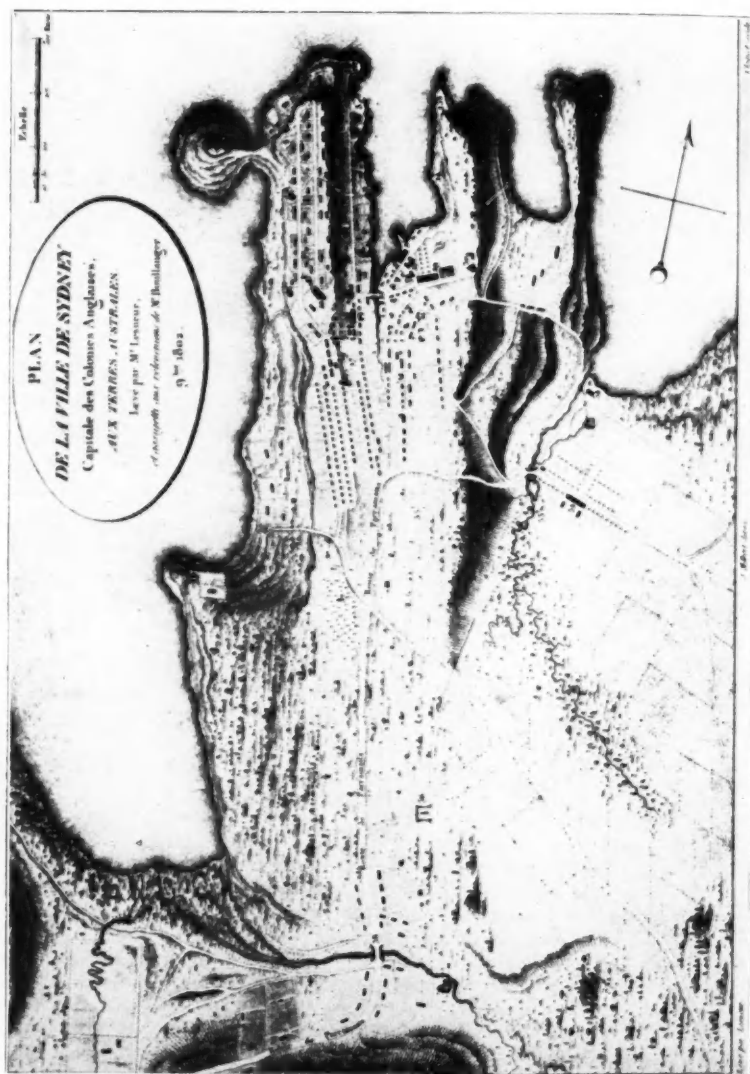


FIG. 2.—The first satisfactory map of Sydney, showing the plan of the settlement in 1802. The large indentation on the west is Cockle Bay (now Darling Harbor); Sydney Cove, Farm Cove, and Palmer's Cove (now Woollloomooloo Bay) occur in order from west to east. (Courtesy of the Mitchell Library, Sydney.)

land were other important factors in the selection. Within a few days the entire fleet was brought around from Botany Bay, and the establishment of the nuclear settlement, which was to develop into the modern Sydney, was initiated.

Tents were distributed along both gently sloping banks of the small stream entering Sydney Cove (Fig. 2). Several poorly aligned roadways extended southward from the head of the cove along both banks of the creek and they formed the principal elements in the structural pattern of the settlement. Sydney Cove was the focus of life in the early community. Water was obtained from the rivulet, in the channel of which several "tanks" (basins) were later excavated for storage purposes. Fuel and building materials were secured from the eucalyptus forest which covered the site. A number of acres of land were prepared for cultivation at the head of Cockle Bay (now Darling Harbor), at Farm Cove, and at Palmer's Cove (now Woolloomooloo Bay). Although a half-hearted attempt was made to produce foodstuffs, owing to the inexperience of the transportees and the failure of the authorities to provide tools and guidance, the settlement was almost wholly dependent on supply ships for sustenance. When they failed to arrive on schedule the colony faced starvation.

Thus the expedition was landed and housed on the shores of a new country whose resources were entirely unknown, and with the pious hope that those transported would improve their ways and soon become self-supporting. The fact that the site proved adequate not only for the original penal depot but later for a city of over a million inhabitants may be regarded as one of the fortunate accidents in the occupation of Australia.

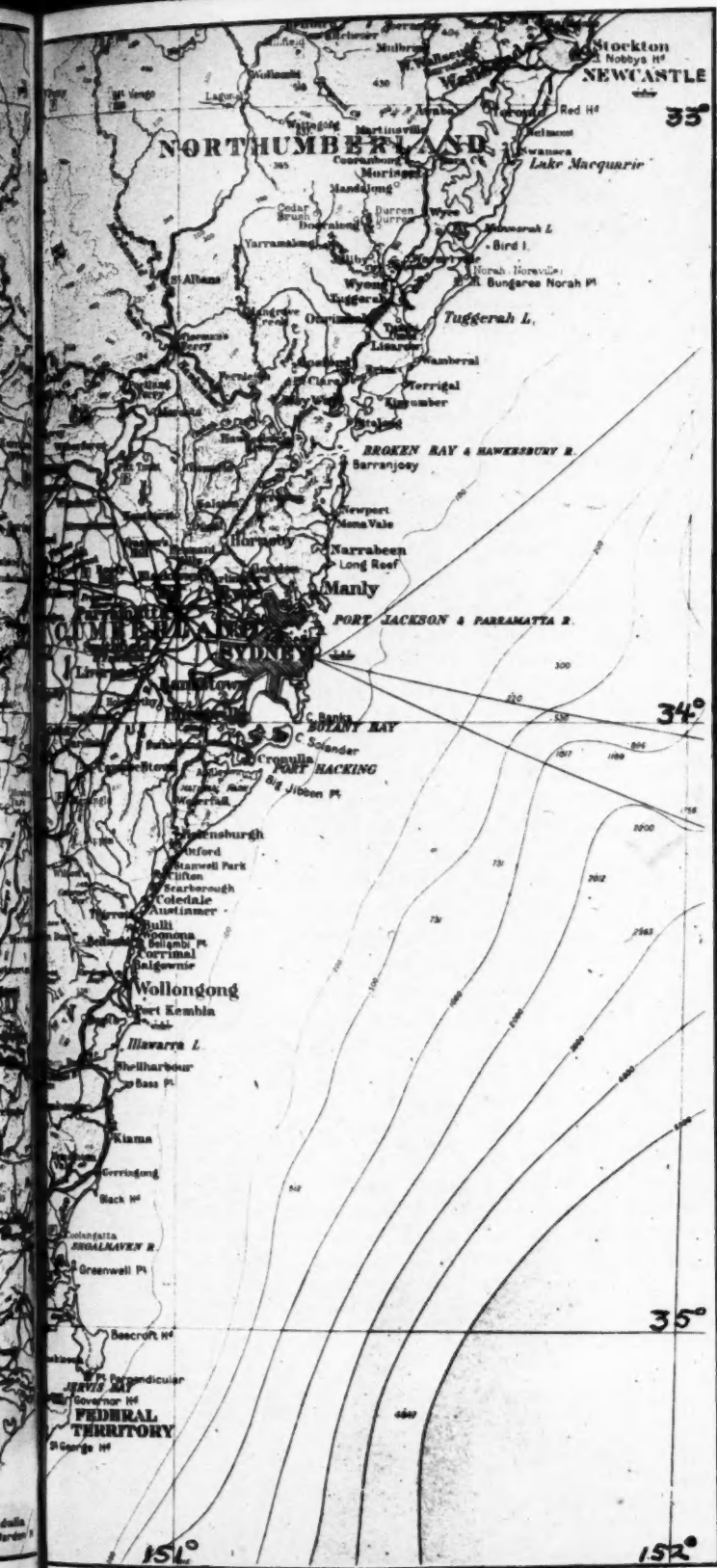
EXPANSION OF SETTLEMENT AND STREET PATTERN

Occupation of the Sydney site spread from the margins of the cove southward along the axis of Tank Stream and to the east and west along the low ridges which paralleled the rivulet and defined its drainage limits (Fig. 2). Tents were gradually replaced by "wattle-and-daub"⁵ huts for the prisoners and by structures of split slabs for the soldiers and their officers. The narrow lowland strip along the west side of the cove was occupied by government storehouses, wharves, boat repair works, and similar structures. The precipitous character of the east margin of the cove discouraged its early development. The headlands of the cove were occupied by batteries of guns.

⁵ A rough mode of architecture common in early Australia. Walls consisted of stout stakes driven firmly into the ground and thickly interlaced with the tough, lithe wattle branches. Both sides were then plastered with a clay mortar and a thatch or bark roof was erected.

FIG. 3.—Portions of the Sydney and Canberra Sheets of the International Millionth Map. Slightly reduced from the original scale of 1:1,000,000. Elevations on the land are shown at intervals of 100 meters.





In order to provide additional building materials small brick-works were early established at the heads of Palmer's Cove and Cockle Bay. Quarries were opened along local outcrops of sandstone. Windmills for grinding grain were constructed on the higher points of the ridges to the east and west of the settlement.

The very limited amounts of good agricultural land near Sydney Cove soon led to the development of more extensive tracts at Parramatta, near the head of the estuary, and to the northwest at Richmond and Windsor along the lower Hawkesbury River (Fig. 3). The authorities were inclined to rely, however, on outside sources of supplies, and they were especially desirous of keeping all occupation within a compact and easily controlled area. Such was the condition of Sydney during the first twenty years of its existence under the administration of five different military governors.

During the period 1809–1822, under the governorship of Lachlan Macquarie, important developments took place in many parts of eastern Australia. The opening of the great interior to grazing by the discovery of a feasible passage over the Blue Mountain Plateau in 1813 was a major factor in the early development of Sydney (Fig. 3). The plateau, with maximum elevations greater than 3,500 feet, presents a steep escarpment to the east which for many years was an insurmountable barrier to westward expansion. Streams notching the margin of the high sandstone front flowed in deep gorges which were useless as means of approach. Finally, the ridge dividing the Cox's and Grose rivers was found to provide a practicable route over the plateau surface. A road was constructed in 1815 along that ridge and much later the railroad ascended along the same route. Recognition of the greatly increased possibilities for settlement beyond the Blue Mountains soon caused authorities to regard Australia as a land for colonization by free immigrants rather than as a mere prison depot.⁶ Sydney's development proceeded apace with the arrival of free settlers who began coming in important numbers during Macquarie's governorship.

Another of the significant accomplishments of Macquarie was the realignment and improvement of Sydney's town pattern (Fig. 4). Streets were widened to fifty feet (including footpaths), names were applied, and wooden fences were set back to correspond with property lines.⁷ Hyde Park was set aside for public recreation at the southeast margin of the occupied city and the Botanic Gardens and the Domain, fronting on Farm Cove, were improved. A public market and wharf were established on Cockle Bay to which produce from the outlying farms could be delivered by

⁶ Scott, Ernest: *A Short History of Australia*; (Oxford) 1918, p. 121.

⁷ Bertie, C. H.: *The Story of Sydney*; (Sydney) 1933, p. 54.

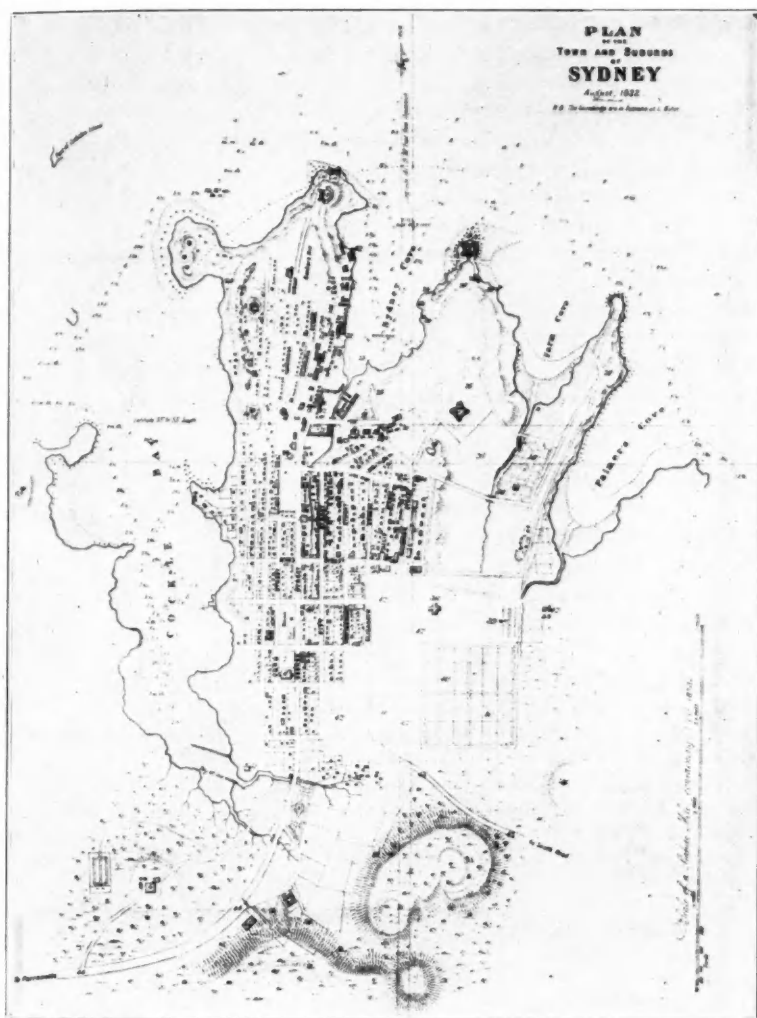


FIG. 4.—The plan of Sydney in 1822 at the close of Governor Macquarie's administration. Formalization of the city plan had taken place and considerable growth is indicated. Comparisons with later maps show certain modifications of this somewhat ideal plan. (Courtesy of the Mitchell Library, Sydney.)

boat. Some fine public buildings of late Georgian style were constructed of local sandstone with the aid of convict labor. Roads were built to give access to many newly created towns in the coastal and interior portions of New South Wales.⁸ While the population of the colony numbered about 10,000 persons in 1810, it amounted to about 30,000 in 1822, and most were situated within a forty-mile radius of Sydney Cove comprising the area now designated as Cumberland County (Fig. 3).

The basic outlines of Sydney's modern street pattern, not only in the central commercial core but also in outlying districts, were established in the early period (Fig. 5). The principal roadway leading out of the peninsular settlement extended westward along the south margin of the estuary to Parramatta where a branch convict station was established in 1791 (Figs. 1, 2, 4, and 5). Branch roads split off from the main artery to serve other small communities to the southwest, as Liverpool, Campbelltown, and Camden⁹ (Figs. 1 and 3).

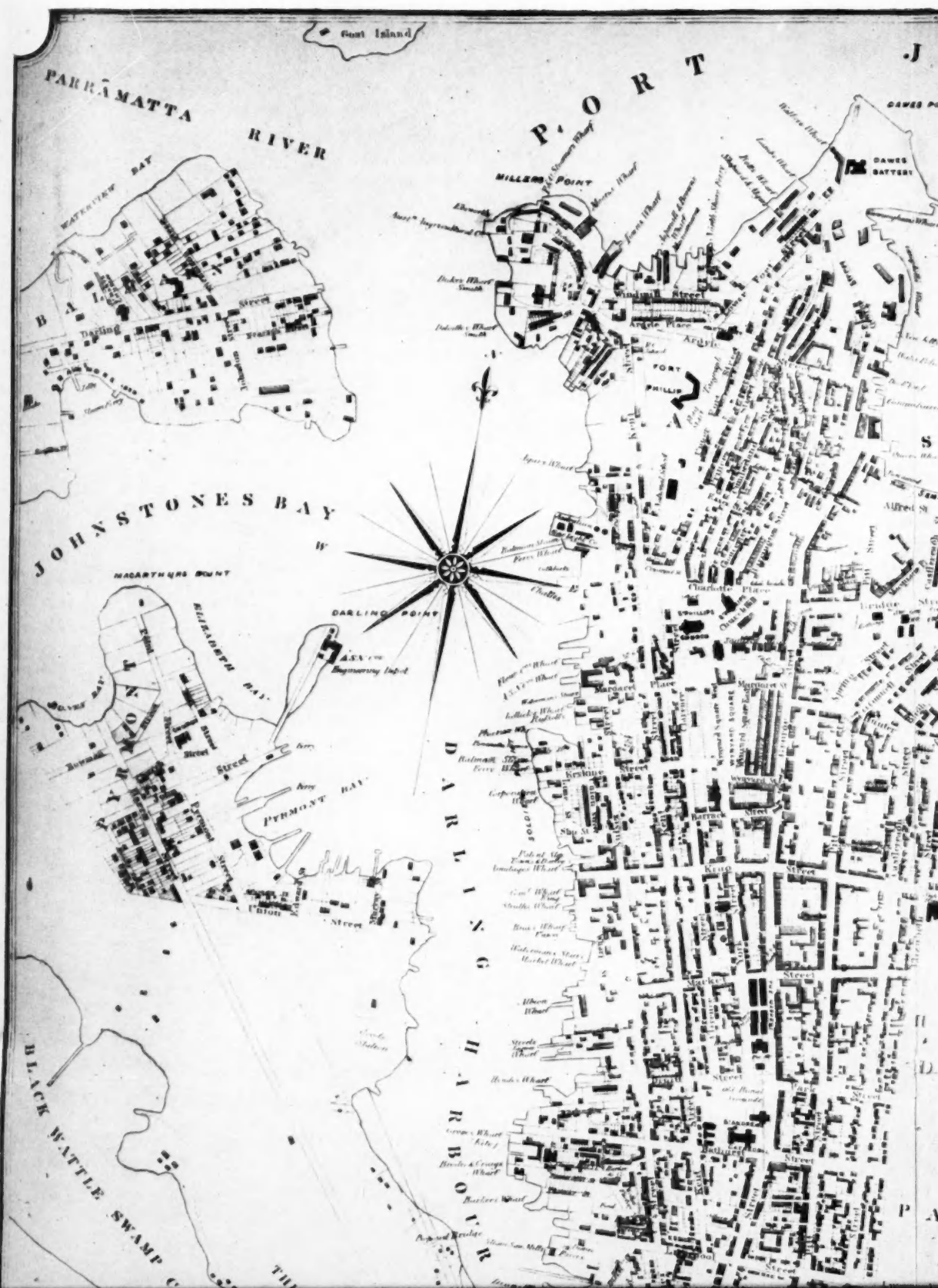
Prominent ridges extending to the north and south of Port Jackson were early utilized for roadways reaching outward from Sydney (Fig. 1). One ridge road extended southward through Marrickville and along the west side of Botany Bay. Another ridge road led to the south headland at the harbor entrance along the drainage divide between Port Jackson and Botany Bay (Figs. 1, 4, and 5). Still another important ridge road extended northwest toward Hornsby and the lower Hawkesbury River from a point on the north shore opposite Sydney Cove (Figs. 1 and 3). Ridge-ways provide a major clue to an understanding of the basic, diagonal road pattern in the vicinity of Sydney. Narrows along the upper reaches of Port Jackson and along other local estuaries also contributed to the orienta-

⁸ A monument in Macquarie Place (a small park one block south of Sydney Cove) bears the following significant inscription: "This obelisk was erected in Macquarie Place A. D. 1818 to record that all the public roads leading to the interior of the colony are measured from it. L. Macquarie, Esq., Governor. Principal Roads. Distances from Sydney—

To Bathurst 137 miles,
To Parramatta 15½ miles,
To Liverpool 20 miles,
To Macquarie Tower at the South Head 7 miles,
To the North Head of Botany Bay 14 miles."

⁹ Lang, John D.: *An Historical and Statistical Account of New South Wales from the Founding of the Colony in 1788 to the Present Day*; (London) 1875, Vol. I, pp. 134-5.

FIG. 5.—The plan of Sydney for 1854 shows unusually well the progress of urban development. The outline of streets and park lands in the central city has remained essentially unchanged.





WOOLCOTT & CLARKE'S MAP

OF THE
City of Sydney
with the additions of

RALPH AND ELEANOR PHIPPS, DALL,
RAE, RYAN, PADDINGTON & CO.
1854

REFERENCE

- A Coppers Ward 1 Parish of St. Phillip
- B Parramatta Ward 2 Parish of St. James
- C Church Ward 3 Parish of St. Lawrence
- D Macquarie Ward 4 Parish of St. Andrew
- E Cook Ward 5 Parish of St. Andrew
- F Phillip Ward 6 Parish of St. Andrew

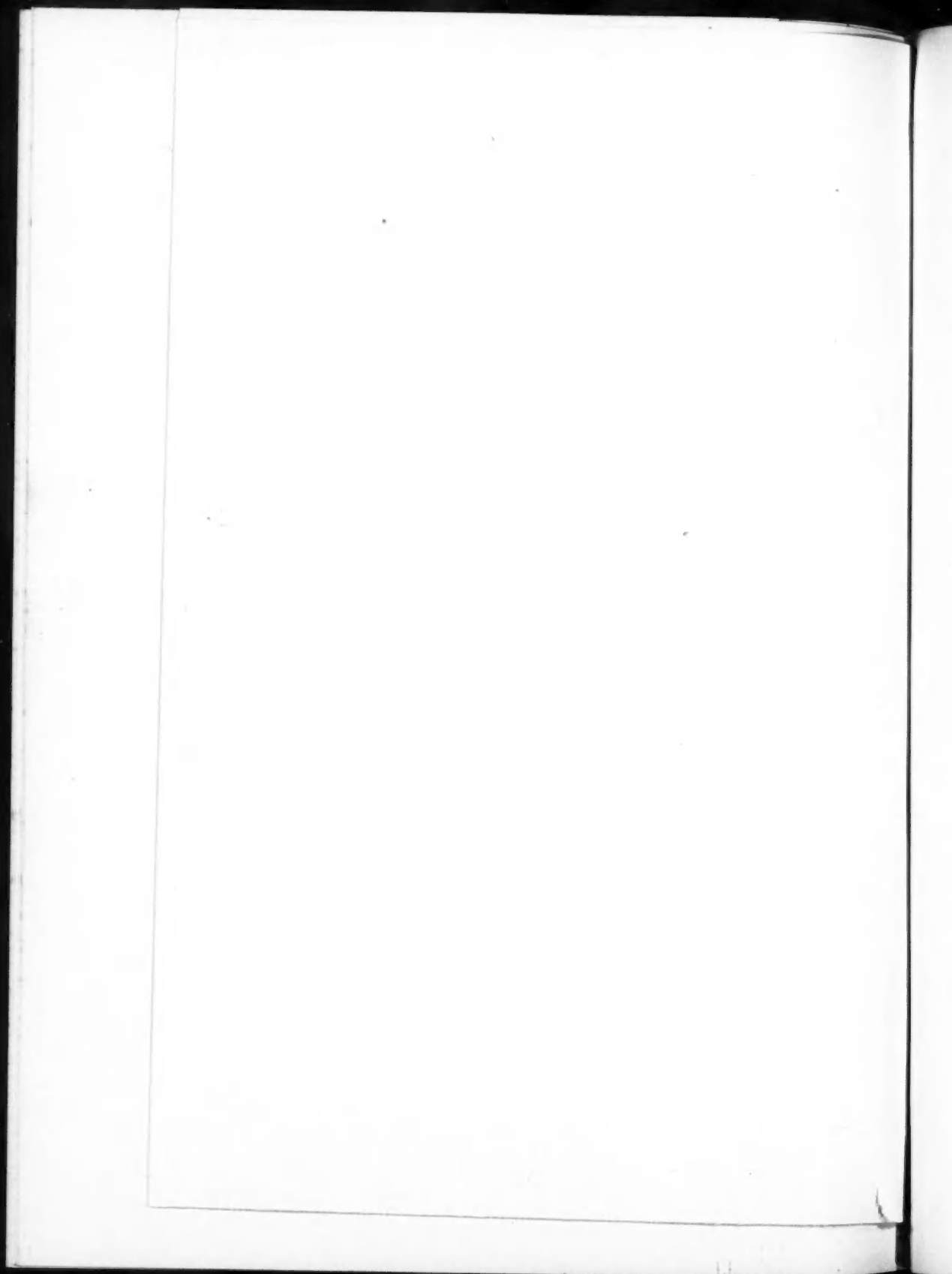
WARD BOUNDARY
PARISH BOUNDARY

Public Buildings

Eng'd by J. Carmichael Sydney







tion of important roadways. Those early roads provided the framework into which the more detailed street pattern of modern Sydney was fitted (Fig. 5).

Another important influence on Sydney's pattern of growth was the system of land subdivision. Irregular tracts of land were allotted by the early governors to individuals who in turn subdivided their holdings as population expanded.¹⁰ Little effort was made to adjust the street patterns of new subdivisions to those already established. In some tracts extremely narrow streets and small lots were outlined and they ultimately developed into slum neighborhoods. As the desirability of wider streets came to be more fully realized, a minimum width of one chain (sixty-six feet) became standard. In relatively few places were streets laid out in conformity with the contours. Urban development usually avoided poorly drained lowlands but spread widely over the undulating upland surfaces.

The highly diversified relief of the Sydney site, the deep penetration of Port Jackson and its many branches, and the unsystematic character of land subdivision and survey are factors of major importance in accounting for the seemingly disorderly character of Sydney's modern street pattern.

PHYSICAL CHARACTERISTICS OF THE SITE

Sydney stands on the seaward margin of an area of varied relief bounded roughly on the west by the undulating plains of the Nepean River, on the north by deeply entrenched Broken Bay, and on the south by the similar Port Hacking indentation (Figs. 1 and 3). The area thus defined is about twenty miles in width from east to west and thirty-five miles in length along the coast. Much land about the north, west, and south margins of Sydney, and within the area just delimited, is sparsely occupied, thus providing space in which the city may expand if needs arise.

Sydney is situated at a low point near the coast from which center the principal railway and highway routes to the north, south, and west are forced to rise. The main North Coast Railway rises to seven hundred feet on the Hornsby Plateau within a dozen miles of Port Jackson. The Nepean Uplift rises gradually to the south but the South Coast Railway attains an elevation of seven hundred feet about twenty miles distant from central Sydney. At Penrith, forty miles to the west of Sydney, an abrupt 1,500-foot escarpment marks the edge of the Blue Mountain Plateau, the summit of which has an elevation of more than 3,500 feet.

Along with much of the coast of New South Wales the Sydney area was subjected to deep submergence in relatively recent geological time, as indicated by the drowned river valleys of Port Jackson, Botany Bay,

¹⁰ Bertie, C. H.: *The Story of Sydney*; (Sydney) 1933, pp. 67-8.

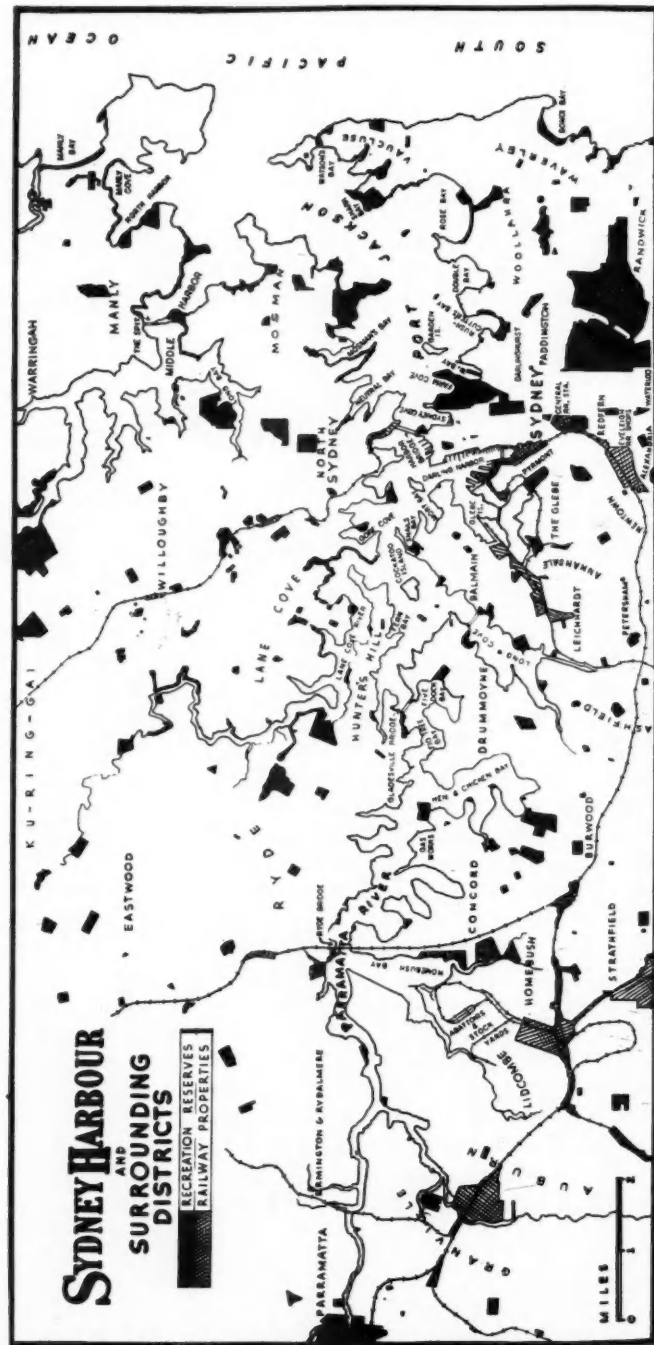


FIG. 6.—The somewhat detailed relationships of certain important aspects of present-day urban development to Port Jackson and its many bays are shown. The many tracts of land along the waterfront devoted to public recreation are noteworthy. The limited contact between railway services and the harbor is clearly demonstrated. The names of the principal municipalities comprising Greater Sydney are shown.

George's River, Broken Bay, and Port Hacking. A more recent slight emergence has produced stretches of narrow coastal plain along a shoreline generally bordered by precipitous cliffs, some fertile lands about the margins of rivers and bays, and many sandy crescent-shaped beaches between projecting rocky headlands.

Port Jackson was carved 350-400 feet deep by an ancient stream across a narrow zone of uplift at right angles to its lower course (Fig. 6). Its headwaters near Parramatta were scarcely affected by uplift and remained in a mature stage. The lower gorges were later penetrated by the sea to a depth of 150 feet due to subsidence of the coast, thus creating the labyrinth of deep waterways which constitute the present harbor. The higher elevations of the north shores of Port Jackson are apparently not due to faulting but due to the normal upward folding of the strata forming the Hornsby Plateau.¹¹ Elevations of the estuary shoreline diminish steadily toward the west and become slight at Parramatta. The capture of the headwaters of the formerly larger river emptying into Port Jackson by the Hawkesbury River has kept the estuary relatively free from silt.

Botany Bay presents many significant contrasts to Port Jackson. The subsidence of an area of low relief produced an extensive embayment with regular shorelines and shallow depths (Figs. 1 and 3). Partial emergence at a later time produced extensive flats about most margins of the bay. Large sections of the lowlands were later mantled by thick deposits of dune sand. George's River presents a complex embayment pattern similar in many respects to Port Jackson. Owing to heavy deposits of silt and sand, however, brought down by its tributaries, the estuary is comparatively shallow. Cook's River penetrates an area of low relief and resembles the Parramatta River portion of Sydney Harbor.

Port Hacking is as deeply entrenched as Port Jackson and its scenic shorelines afford innumerable sites for cottages and other forms of resort development. Since the streams entering Port Hacking carry much silt that estuary is too shallow for large boats. Access to the interior likewise is difficult.

Broken Bay consists of the drowned lower portion of the relatively large Hawkesbury River. High sandstone cliffs (600-900 feet) border most of the shoreline and make for an unusually scenic waterway. Lowlands for agriculture or town development are unavailable except along the upper reaches of the principal arms of the bay. Scrub eucalyptus forest covers most of the uplands, which are commonly difficult of access and little inhabited.

¹¹ Taylor, G.: "The Geography of the Coast near Sydney"; *Proc. Pan-Pacific Congress (Australia) 1923*, Vol. II; *Guidebook to the Excursions in the Sydney District*, pp. 11-21.

Another important environmental element of the Sydney site is the massive Hawkesbury sandstone which is exposed throughout much of the occupied city area. The thick layers of sandstone, deeply incised by streams, give to the area its outstanding physiographic features and much of its scenic beauty. The sandstone formation also accounts for the high cliffs which extend for miles along the ocean front. Hawkesbury sandstone is quarried in many localities about Sydney and it is a common local building stone (Fig. 7). The Wianamatta shales, which commonly overlie the



FIG. 7.—A small quarry showing the character of the Hawkesbury sandstone which underlies all the eastern suburbs of Sydney.

sandstone in the western and southwestern suburbs, are responsible for the undulating and low relief of the open country to the west of Sydney. The shale beds furnish the raw material for the extensive manufacture of bricks in many parts of the metropolitan area.

Most of the soils about Sydney are light-colored, shallow, and sandy, having been formed by the disintegration of the resistant and siliceous Hawkesbury sandstone. The extensive Hornsby Plateau to the north is deeply dissected, generally sterile, and of little agricultural value. The Nepean Uplift to the south is less dissected but much of the surface has never been cleared of native growth. Many small farms, dairies, and orchards are to be seen in both areas but many are discouraging ventures

economically. Small tracts of lowlands about the margins of Botany Bay and composed largely of dune sand are used intensively for market gardens by Chinese. Considerable tracts of agricultural land lie along George's River near Liverpool and Campbelltown. Poor soils account principally for the broad girdle of unproductive and largely unimproved land which borders Sydney on most sides. Owing to the unproductive character of much of the land within a hundred mile radius of the city, Sydney is seriously penalized with transportation costs on the large quantities of food-stuffs which must be hauled long distances.

At Parramatta and on the Nepean Plains to the west dark reddish-brown soils, formed from Wianamatta shales, are deeper, less permeable, and more productive (Fig. 3). Large tracts are used for cattle and sheep rather than for crops as might be expected in such close proximity to a great city. The best soils in the vicinity of Sydney are of fluvial origin, and they lie principally along the margins of the Nepean and Hawkesbury rivers at Camden, Penrith, Windsor, and Richmond. Most of those lowlands are intensively farmed but they are often subject to flooding.

The Sydney area lies within the warm, moist, coastal climatic belt. The rainfall of forty-seven inches has a late-summer, autumn, early-winter maximum but even the driest months (August-December) have an average precipitation of nearly three inches each. Rainfall diminishes inland from Sydney to the base of the Blue Mountains, Penrith receiving less than thirty inches. Temperature extremes characteristic of the interior do not strongly affect the coastal belt although west winds cause hot dry days at Sydney in summer and some relatively cold days in winter.

Despite the generally moist climate of the Sydney area the native vegetation is xerophytic and stunted on the sandstone areas (Fig. 8). Plants are generally much branched, and leaves are small, narrow, and of hard texture. Xerophytism is due mainly to light soils but dry west winds and intense sunlight are important contributing factors.¹² Timber is normally of a scrub eucalyptus type seldom attaining sizes suitable for saw-log purposes. All usable timber is regularly culled from such stands. The undergrowth is of a dry sclerophyllous type and grasses are scarce. Little feed for livestock is available at any season on those lands. Fires rage through such growths during dry summers, filling the air with smoke and ash for days. Large areas of "bush" are held for recreation purposes in the vicinity of Sydney.

¹² Hamilton, A. G.: "Notes on the Botany of the Sydney District"; *Proc. Pan-Pacific Congress (Australia) 1923*, Vol. II, *Guidebook to the Excursions in the Sydney District*, pp. 4-10; and Osborn, T. G. B.: "Plant Life in the Sydney District"; *Handbook for New South Wales*; Aust. and N. Z. Assoc. Adv. of Science, (Sydney) 1932, pp. 24-34.



FIG. 8.—A sample of the native vegetation preserved in Nelson Park on one of the peninsulas projecting into the south margin of lower Sydney harbor. The roadway surface consists of the outcrop of Hawkesbury sandstone.

Of such types are the public reserves, National Park and Kuring-gai Chase, about fifteen miles to the south and north of the city respectively (Figs. 1 and 3). They contain more than 35,000 acres each of uninhabited natural woodland. They also have long frontages for recreation purposes on the scenic Port Hacking and Broken Bay estuaries.

The shale areas were formerly covered by an open eucalyptus forest but agricultural and pastoral interests removed most of that cover many decades ago. In places, however, the low-lying and impervious shale soils are poorly drained and they still support dense growths of indigenous tea shrub. Although eucalyptus trees were characteristic of both sandstone and shale areas, different species predominated.

SYDNEY'S FOCUS UPON PORT JACKSON

Throughout its history Sydney has borne many intimate relationships to its harbor. As has been seen, the original settlement was established at Sydney Cove, and the present commercial core of the city remains within a few blocks of the principal wharves. A large share of the agricultural and pastoral products of the state move to world markets through this center. Numbers of important manufacturing establishments are situated about the

margins of the estuary principally for convenience in receiving raw materials and fuel. Many others are located within short distances of the harbor. The extensive foreshores of Port Jackson have attracted a large share of Sydney's residential development. The protected waters and many beaches provide recreational facilities of great significance. Thus Sydney comes to a focus upon Port Jackson's extensive shoreline and the inter-relationships between city and estuary comprise a major part of its urban geography.

Port Jackson is one of the world's most satisfactory natural harbors. The entrance lies between precipitous headlands and it is nearly a mile wide with eighty feet of water (Fig. 6). The principal portion of the estuary extends inland along an approximate east-west axis for a distance of fifteen miles and it is offset from the opening sufficiently to escape the effects of strong easterly and southeasterly storms. Many large and small indentations occur along both the north and south sides of the estuary which serve as anchorages for large and small ships. At its inner margin Port Jackson merges imperceptibly with the Parramatta River.

The total area of water surface in Sydney Harbor is twenty-two square miles, of which nearly one-fourth has natural depths greater than thirty-five feet. Separate channels are provided for incoming and outgoing vessels and abundant room is available in the lower harbor for maneuvering vessels as well as for anchorage. Being a terminal port, vessels are commonly held in port for relatively long periods thus requiring commodious anchorage areas. A tidal range of only three to six feet introduces little or no difficulty in the "working" of ships at the wharves.

Lands along the south side of the estuary rise steeply to elevations of 200-300 feet for several miles inside the entrance but the shoreline gradually diminishes in height to the west. It is along that margin, with its diversified relief and strongly indented outline, that the principal portions of Sydney have spread.

The north shore is somewhat higher, with elevations of 200-400 feet being characteristic, and steep, rocky slopes or cliffs commonly rise from the water's edge. As on the south shore, average elevations of the upland diminish from east to west. Important residential suburbs have arisen along much of that shoreline despite the somewhat difficult access brought about by the deep dissection of the upland surface.

Middle Harbor, a second important division of the estuary, extends for about six miles in a northwest direction from the ocean entrance into the Hornsby Plateau. High sandstone cliffs border most of that arm and make difficult any contact between the residential uplands and the water. Just inside the estuary entrance is a small embayment usually referred to as North Harbor.

Owing to the extensive and intricate pattern of Port Jackson a large proportion of the city enjoys intimate contact with the water environment, the shorelines of the estuary totaling 188 miles. Close proximity of the outer coastline and its many surfing beaches further promotes the maritime outlook of Sydney's inhabitants.

Marked contrasts in the predominant types of land use make it possible, and convenient for purposes of discussion, to divide Sydney into the following general districts: (1) the central business core, (2) the commercial harbor district, (3) the western and southwestern industrial and residential area, (4) the southern manufacturing district, (5) the eastern residential suburbs, (6) the north shore residential suburbs, and (7) the Botany Bay district. All of those districts, except the last, bear important relationships to Port Jackson and have direct contact with the estuary margins. The relatively unimportant focus of metropolitan development upon Botany Bay

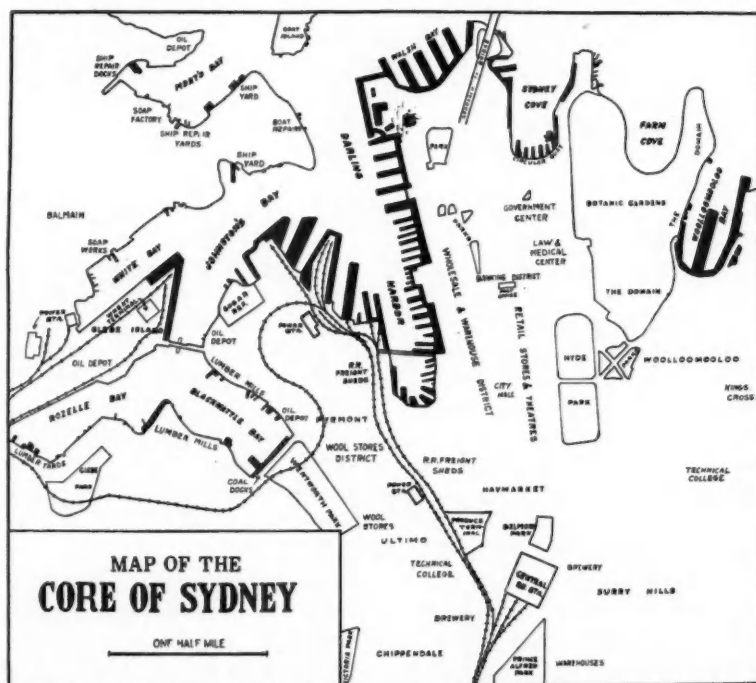


FIG. 9.—The core area of Sydney showing some of its significant cultural elements and their general areal arrangement.

emphasizes by contrast the paramount importance of Port Jackson. Broken Bay and Port Hacking are too far removed to have important influence upon Sydney's areal arrangement.

Central Business Core

Near the head of Sydney Cove lies the center of Sydney's chief business district (Fig. 9). Following the axis of the original settlement it extends from the principal harbor ferry terminal at Sydney Cove southward for nearly two miles to the Central Railway Station, the chief terminal of the state railway system. The business district is scarcely more than a half mile wide, being bordered on the east by long established park lands and on the west by Darling Harbor, with its extensive overseas and interstate docks. The principal radial boulevards of the metropolitan district, the tram lines, and bus services also converge upon that area. The harbor bridge is an important factor in directing north shore residents into the center of the business district (Fig. 10). All forms of water and land transport are brought to a focus within a surprisingly small radius within the central city. Although the neighborhood type of business establishment is scattered throughout the metropolitan area, the central business district serves the entire city in many significant ways. The intimate relationship of the commercial district to the waterfront is one of its most important characteristics.

Within the commercial core of Sydney are the principal government, financial, commercial, and professional offices and establishments of the State (Fig. 9). Owing to continued expansion of the functions of the area and because of the difficulty of extending into new territory, higher buildings are becoming increasingly necessary. Although many of the newer buildings reach the legal limit of 150 feet, most buildings in the area still average nearer fifty feet in height. George and Pitt streets, which occupy positions to the west and east respectively of the former Tank Stream and which extend without interruption between Circular Quay and the railway station, are the principal retail shopping streets (Fig. 5). York, Castlereagh, and Elizabeth streets, along with a half dozen short cross streets near the center of the core area, share in lesser degree the retail trade. Large department stores are grouped near the south end of the core area within easy reach of the railway station and at points where many tram lines serving the western and southern residential suburbs enter the congested core area. More exclusive retail stores are situated near the middle of the shopping district and easily accessible to transportation lines serving the more exclusive eastern and northern suburbs. Theatres and hotels occupy positions near traffic foci similar to department stores. George Street is of ample width for modern traffic but on most others trams and automobiles are permitted to move only in one



FIG. 10.—The Sydney harbor bridge connects the north shore residential suburbs with the central city across a conveniently situated narrows scarcely more than a quarter-mile wide. The main bridge consists of a steel arch span of 1,650 feet length although the total length of the bridge with approaches is $2\frac{1}{4}$ miles. Shipping has a clearance of 170 feet at high water. The bridge provides for electric railways, automobiles, and pedestrian traffic. With a maximum height of 440 feet above mean sea level the bridge is a landmark which may be seen from all parts of the metropolitan area. At a cost of £10,000,000 the bridge is regarded as one of the outstanding civic features by most citizens. The bridge is here viewed from the Botanic Gardens on Farm Cove.

direction. A subway loop, only recently completed between Circular Quay and Central Railway Station, helps greatly to reduce pedestrian congestion on the surface throughout the district.

State government offices are located at the northeast margin of the area along with the principal libraries, the art gallery, and the museum. Municipal offices are situated near the center of the area. Central banking establishments are concentrated along Martin Place in close proximity to general office buildings, the post office, commodity and stock exchanges, insurance firms, shipping offices, and travel agencies. The preponderance of men in the northern governmental-financial-business section of the core area is a significant contrast to the preponderance of women pedestrians in the central and southern retail shopping and theatre districts. A notable concentration

of medical offices occurs on Macquarie Street facing the Botanic Gardens and in close proximity to the Sydney Hospital (Fig. 11). In similar man-



FIG. 11.—Macquarie Street, opposite the Botanic Gardens, is the center of concentration for the medical professions. Some of the contrasts between old and new style office buildings are illustrated.

ner law offices are to be found grouped closely about the law courts. Businessmen's clubs are located in the financial district. A surprising number of large churches are situated in the core area due to early establishment and the ease of access by mass transportation facilities.

Wholesale establishments are grouped somewhat according to their wares along the entire west side of the commercial core on York, Clarence, Kent, and Sussex streets in close proximity to Darling Harbor and the principal railway freight terminals. Printing establishments and other light industries are found there also. Near the southwest corner of the area extensive wholesale produce markets are conducted. Chinese merchants are conspicuous in the vegetable section.

Automobile traffic is much less heavy in the core area than in American cities of corresponding size. Greater dependence is placed on surface and underground railway transportation in Sydney's core area. Streets are inadequately illuminated by small overhead lights, and except on Friday night (pay day), when stores remain open until nine o'clock, the core area is relatively quiet and free from traffic. Practically all business ceases Satur-

day at noon, for that is the beginning of the week-end holiday period. Side-walks in the retail districts are generally shaded by cantilever extensions from store fronts which add to the comfort of shoppers on hot days and in wet weather but often detract from the appearance of the already too-narrow streets.

Many of the older buildings in the core area are constructed of local Hawkesbury sandstone. Extensive quarries have been operated in the past along the precipitous east side of Darling Harbor and on Pyrmont Peninsula. When large buildings are constructed in the business area basements must nearly always be blasted out of solid sandstone, as was also the case with the underground railway. The northern portion of Sydney's core area, with its short angular streets and old English architecture, bears many resemblances to parts of old London.

Outlying shopping facilities are found along most of the tram lines and principal highways radiating from the center of the city. The widespread character of Sydney's residential suburbs makes it essential that daily necessities be obtainable in neighborhood stores. The restricted size of the central core area tends to limit its use to metropolitan functions and to crowd local commercial establishments out along the radiating transportation routes which commonly are the ridge-ways. At a few outlying centers of exceptional transportation focus, as in North Sydney and Kings Cross (Darling-



FIG. 12.—Characteristic front view of a terrace of old brick houses in Waterloo such as occur in all parts of old Sydney.

hurst) (Figs. 6 and 9) important and varied satellite business centers have arisen. Parramatta, because of its long life as an independent urban agglomeration and due to its considerable distance from Sydney proper, functions in many respects as a complete and separate urban unit.

Bordering the central business district on the east, west, and south sides are situated older and often decadent residential neighborhoods. The municipalities of Paddington, The Glebe, Newtown, Waterloo, and Redfern are representative (Fig. 6). London type "terraces"¹³ are the most characteristic type of residence in those neighborhoods, although many single-family cottages of simple design also occur (Fig. 12). Old residences frequently occur in the centers of blocks now primarily devoted to commercial or other business uses—relics of earlier forms of occupancy. A maze of narrow streets, small lots, and decadent buildings, combine to form slum neighborhoods inhabited by families of low income (Fig. 13). In recent



FIG. 13.—In some of the older, crowded portions of Sydney, bordering the central city on the south and west, many of the narrow alleys have developed into slum-type residential streets. Little Riley Street in Redfern is shown.

¹³ A term loosely applied to a series of connected dwellings placed side by side. The usual terrace consists of a multiple unit, one- or two-story, brick residence building situated at the edge of the sidewalk. Firewalls separate the identical units which are repeated along the full length of the individual property.

years some of the worst portions have been cleared by municipal authority and plans are under way for improved types of urban housing.¹⁴

The Commercial Harbor District

Most of the land- and water-borne commerce of New South Wales converges at Sydney. Governmental policy and the advantages of nodality in the assembly and marketing of primary products are largely responsible for such centralization. Sydney's principal commercial wharves lie about five miles inland from the harbor entrance and they are closely associated with the central business core (Fig. 9). The principal streets of the business district terminate at the waterfront and it is only a few minutes' walk from the wharves to the commercial offices and establishments of the city. Darling Harbor, just west of the narrows spanned by the harbor bridge, is the chief center of shipping activities, but Sydney Cove and Woolloomooloo Bay, to the east, and Johnston's Bay, with its several minor indentations, also share in the trade of the port. Farm Cove, despite its position within the commercial dock district, is entirely devoted to recreational activities in connection with the early established Botanic Gardens and The Domain. About fifteen miles of waterfront is improved and most of it is publicly controlled. In order to provide the maximum wharf frontage in the easily accessible bays, wharves are commonly projected into the wider stretches of water rather than being built parallel to the shorelines.

The total exports and imports handled at Sydney average about six million tons annually of which sixty-five percent are imports and thirty-five percent are exports. Of the imports approximately two-fifths are from overseas, two-fifths from other New South Wales ports, and one-fifth from other Australian states. Of the exports sixty-five percent go to overseas countries, twenty percent to other Australian states, and fifteen percent to other New South Wales ports. Exports are principally primary products such as wool, hides, wheat, butter, and meat while imports are largely manufactures, timber, coal, and petroleum products. Great Britain is the principal country involved in both Sydney's export and import trade.

The entire east side of Darling Harbor and its northward continuation

¹⁴ The City of Sydney, from the viewpoint of local municipal organization, is composed chiefly of the central business district and the nearby commercial wharves. The geographic city includes nearly fifty separate municipalities each of which maintains its own local government. Owing to the wide responsibility of the State and other special bodies in the provision of urban facilities, such as public transportation, water and sewage disposal, power, harbor control, education, and police protection, the complex pattern of municipal governmental areas is of relatively small consequence. Nevertheless, the difficulty of getting cooperation among the many local political units has interfered with many forms of modern metropolitan planning and improvement.

in Walsh Bay is devoted to the handling of general cargo and passenger traffic by overseas and coastwise shipping lines. Soon after 1900 that stretch of wharves was realigned and thoroughly modernized by the government after a long period of discordant growth in private hands. Effective roadways to serve the entire waterfront were blasted out of the high sandstone cliffs, and slum areas were replaced by modern living quarters for dock workers¹⁵ (Fig. 14). Owing to the diversified character of goods



FIG. 14.—View south along the broad roadway (Hickson Road) serving the wharves and piers along the east side of Darling Harbor. Various kinds of commercial structures and apartment buildings have been constructed wherever possible on the steep upland margin at the left.

handled over those wharves and due to the fact that they are consumed locally in large measure or are warehoused before delivery to inland centers, those important wharves are not served directly by the state railways. Restricted access to that waterfront due to the high bordering cliffs is undoubtedly another factor in explaining the lack of direct railway connections.

On the west side of Darling Harbor and near its head extensive railway

¹⁵ *Official Handbook of the Port of Sydney, N.S.W.*; The Sydney Harbour Trust Commissioners, 1924.

yards and warehouses have been constructed in part on filled ground (Fig. 15). Bulk commodities such as wheat in bags, lumber, bunker coal,

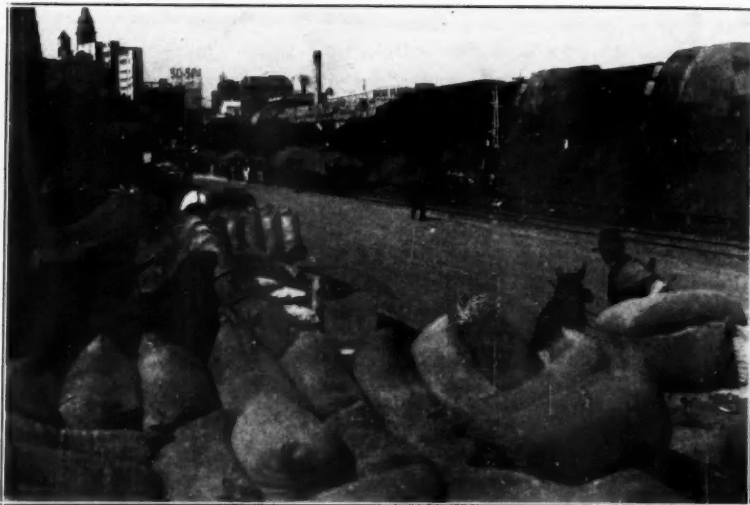


FIG. 15.—Unloading wheat in the freight yards at the head of Darling Harbor. Carloads of wool are to be seen on the higher track. Tarpaulins are used to cover shipments in open railway trucks.

and stone are commonly handled directly between rail and boat. Most wool shipments from the interior arrive at the Darling Harbor railway yards for delivery to the large wool stores (warehouses) which are concentrated in that vicinity (Fig. 16). The construction of new wool stores and other warehouses is steadily crowding out homes in the decadent residential district on Pyrmont Peninsula.

Glebe Island, a peninsula of reclaimed land projecting into Johnston's Bay, is another principal center of shipping to the west of Darling Harbor (Fig. 9). In 1920, the State completed a terminal wheat storage and shipping plant with a capacity of seven million bushels and capable of handling grain in bulk or in bags (Fig. 17). It is served by railways tapping all parts of New South Wales and extensive marshalling yards are provided for handling railway trucks. Prior to 1920 all wheat was exported in bags from the west side of Darling Harbor. By 1935, eighty percent of the exports of wheat from Sydney were in bulk. Since wheat shipments are seasonal, the largest movement being during the three months February, March, and April, provision was also made at Glebe Island for

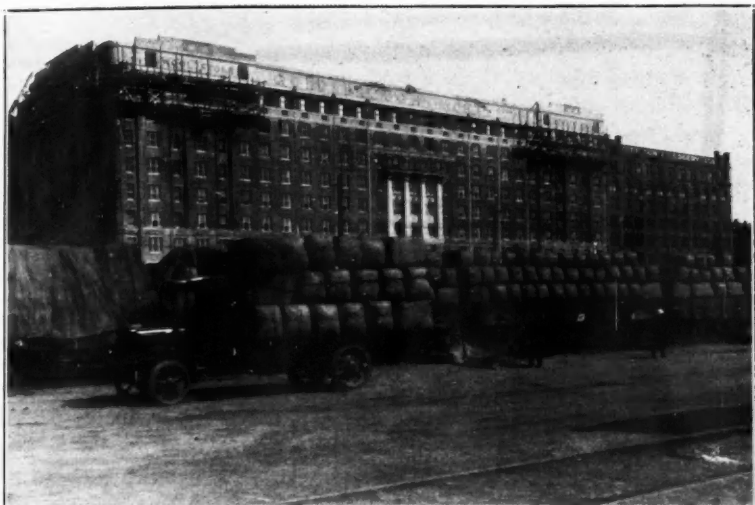


FIG. 16.—One of the large wool stores (warehouses) located at the head of Darling Harbor, in Pyrmont. Bales weigh about 350 pounds each. The wool is being transferred from the railway to the warehouse by motor truck and horse-drawn dray.

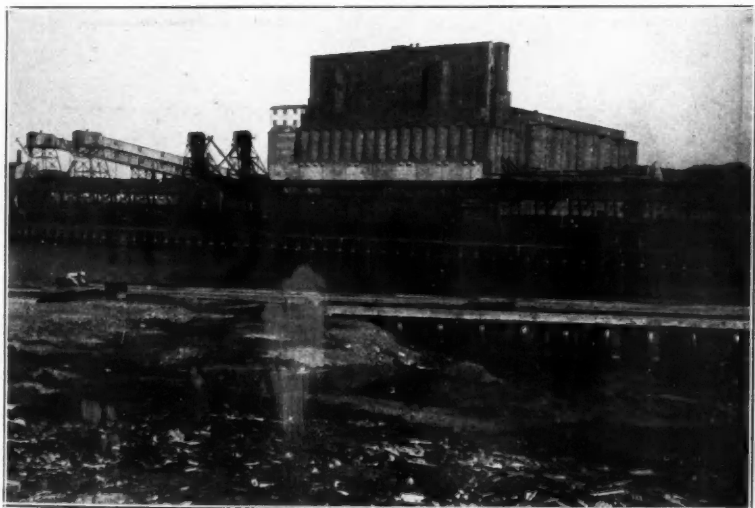


FIG. 17.—Bulk wheat terminal built by the state at Glebe Island for the export of the chief farm crop of New South Wales.

the handling of flour, meats, butter, and general cargo, thus allowing the wharves and conveyors to function throughout the year.

It is significant that Glebe Island and the docks on the west side of Darling Harbor are the only portions of the Sydney waterfront which are adequately served by railways. In 1935, only thirteen and one-half percent of all exports and imports were transferred directly between rail and ship. If wheat, coal, and coke are omitted, only six percent of the trade was so handled.¹⁶ Wool is transferred from the railways to the wool stores and later to the wharves by automobile truck and horse-drawn drays, thus not requiring direct connections between rail and water transport.

Other types of trade which are concentrated in the minor arms of Johnston's Bay are the importation of coal, rock materials, lumber, petroleum products, and raw sugar. High-grade coal is brought by water from Newcastle and distributed to domestic users in small quantities by cart and to larger consumers by rail. In 1935, nearly two hundred million feet of timber was imported from Australian and Canadian sources to meet building needs. Much of the Canadian coniferous timber arrives in the form of logs in order to escape the higher duties on sawn lumber. The logs are discharged in Johnston's Bay, formed into rafts, and towed to lumber mills along the waterfront. Depths have been increased by dredging in all the small bays tributary to Johnston's Bay, and additional industrial and recreational land has been created at their heads by filling operations.

Commercial activities have in considerable measure been crowded out of Sydney Cove by the concentration there of most of the harbor ferry services. Prior to the opening of the Sydney harbor bridge in 1932 more than forty million ferry passengers were handled annually at Circular Quay. After the completion of the bridge the ferry business was cut in half and as a consequence space is again becoming available along the margins of the cove for the handling of overseas passenger business which does not require extensive dock and warehouse facilities. About the margins of the cove numerous old sandstone warehouses, bearing the names of London and Boston firms, continue to serve in the export of wool, hides, skins, and other pastoral products. Tea merchants, coffee roasters, chocolate manufacturers, and importers of cork represent other interesting institutions remaining in that vicinity. The modernization of the cove frontage and the spread of retail business interests toward the ferry terminal, however, are gradually displacing the type of trade which long gave "atmosphere" to the original waterfront.

Woolloomooloo Bay, with its easy access for large vessels, is likewise

¹⁶ *35th Annual Report of the Sydney Harbour Trust Commissioners, 1935*, pp. 11-12.

concerned with general overseas cargo and passenger services. The bay has an unusual setting for the conduct of commerce, being bordered by parklands on the west and by high class residences on the east. It is also several miles distant from commercial, warehousing, and manufacturing districts, except insofar as newly created establishments of those types are gradually crowding out poor residences on the lowlands at the head of the bay. Automobiles are one of the principal items imported over the Woolloomooloo docks and businesses concerned with their storage and retail distribution are notably concentrated in adjacent parts of the city. Sydney newspapers likewise maintain warehouses near the Woolloomooloo docks for the storage of newsprint received principally from Canada.

Wool is exported in large quantities from Woolloomooloo Bay. Wool bears relatively high freight rates and moves to foreign markets on cargo-passenger liners. After the wool sales the bales are trucked from the Pyrmont stores through the congested commercial core of the city to Woolloomooloo Bay, where, after being sent through the high density compresses the bales are delivered to the waiting ships. Direct connections between rail and water are not available at Woolloomooloo nor are they essential in view of the practices which maintain in the sale and handling of wool. Much common labor is required in the collection and dispatch of more than a million bales handled through Sydney annually. It is a matter of no small significance to note that some of the most attractive estates on the promontory just east of Woolloomooloo Bay have long been maintained by the absentee owners of large sheep stations in the interior of New South Wales.

Electricity for metropolitan railway purposes and for some of the southern suburbs is developed by two large power plants, one situated at the head of Darling Harbor, and the other on White Bay. The former was erected in 1899 and the latter in 1918. Another power plant, built in 1904 on Darling Harbor and which formerly served all the central city, has been largely replaced by a modern plant on Botany Bay. A fourth plant near the entrance to Long Cove furnishes electricity to nearby communities. The concentration of coal burning power plants near the center of the power load and on navigable waters is significant.

The most important single commodity arriving at Sydney Harbor from other Australian ports is coal. Sydney is the largest coal consuming center in Australia, utilizing about two and one-half million tons annually or one-fourth the Commonwealth output. More than two-fifths of Sydney's coal is brought by sea from Newcastle, nearly as much comes by rail from the southern field (Bulli), and the remainder comes by rail from the western field (Lithgow). Newcastle coal is especially desirable for gas manufacture

and great quantities are treated in the large gas works located on the upper reaches of the harbor. Western coal is inferior to that from the other fields and it is used principally for railway and power purposes. Bulli coal is excellent for domestic uses. Owing to the generally mild climate most of the coal and gas purchased by householders is used in connection with cooking and water heating rather than with house heating. Most homes do not have central heating units and as a consequence are somewhat uncomfortable during the cool season.

Although coal was at one time mined from beneath Sydney Harbor the 3,000-foot depth of the shaft on Balmain Peninsula proved too great a handicap in competition with mines near the outcrops of the coal basin to the south, west, and north.

Western and Southwestern Industrial and Residential Area

A succession of sprawling suburbs has developed along the south side of Port Jackson reaching from the crowded central city as far west as Parramatta and Bankstown (Figs. 1 and 6). Development has spread principally along the main railways and highways but wherever feasible it covers the numerous peninsulas projecting into the estuary. The residential development is of a type to fit the incomes of factory workers and its density diminishes rapidly as one gets away from public transportation lines. The lower elevations of the inner harbor shoreline, the availability of large tracts of cheap land, and the access to railways and navigable waters have attracted a wide variety of industries. Several of the large shallow bays, however, are practically devoid of industry and shipping. Parks, baths, and small pleasure boat anchorages to serve the residential areas fringe their margins (Fig. 18). Rowing courses are marked out in Long Cove and in the Parramatta River. In many places tracts of land are still devoted to truck farming and fruit growing, both of which were carried on much more extensively before the large expansion of Sydney's western and southwestern suburbs.

Most of the harbor-front industries do not have railway connections but depend on the waterway and on highways for transportation. A series of highway and railway bridges cut across several of the estuary arms and also across the major estuary channel, where they are sufficiently narrow, thus greatly facilitating travel between the peninsular suburbs as well as between the south and north shores of Port Jackson (Fig. 6). Extensive areas of mud flat are exposed at low tide in Homebush Bay, Hen and Chicken Bay, and elsewhere. In places industrial lands are being created by filling in bay margins with dredgings obtained from navigation channels.

Ship repair yards and boat works are a type of industry widely dis-

tributed along the south shore from Darling Harbor west to Parramatta. The larger ship building and repair yards are in close proximity to the commercial docks, as on Mort Bay and Snails Bay, at the head of Balmain Peninsula, on Cockatoo Island, and on the adjacent north shore near the entrance to Lane Cove River.

The principal bulk storages for petroleum products, all of which are imported from overseas, are situated along the south shore waterfront adjacent to the major shipping docks, as at Glebe Island, Blackwattle, Rozelle, White, and Mort bays and on the north shore at Fern Bay and Gore Cove.

Sawmills and wood-fabricating plants are concentrated principally in Blackwattle and Rozelle bays, at the entrances to Long Cove and Five Dock Bay, and at the Rhyde Bridge narrows. Logs are discharged from vessels at convenient points in the harbor and are rafted to the mills. Lumber drying yards, planing mills, and box factories are closely associated with the sawmills. Native eucalyptus supplies most needs for hardwood lumber but most of Sydney's softwood timber is obtained from Canada.

A large sugar refining plant on Johnston's Bay (Pyrmont) has been



FIG. 18.—View to the south across the Parramatta River into Five Dock Bay, showing the relatively low-lying character of the inner harbor margins. Except for the large lumber mill at the entrance, the bay is devoid of industry due to its shallow depth. Residential development borders the bay on most sides. The foreground is reserved as an informal public park.

operated for many years by a concern having refineries in all the capital cities of Australia except Hobart (Fig. 9). Raw sugar is received over a private dock from cane mills in northern New South Wales and Queensland. A distillery and other by-product plants are operated in connection with the refinery. Most of the sugar output is marketed locally in Sydney and the delivery drays drawn by teams of heavy draft horses are characteristic features on Sydney Streets.

Large soap and chemical works are situated at the entrance to Long Cove, and on White and Mort bays of Balmain Peninsula. Raw materials and fuels are obtained over company docks.

Industries on Drummoyne Peninsula are located only on the north frontages easily accessible from the main estuary channel. A large rubber tire factory, a saw milling and wooden box plant, an extensive wire works, and a large confectionery factory are the principal industries. Most of the plants are laid out on steep slopes but they have waterfront facilities for receiving raw materials and fuels (Fig. 19). Hen and Chicken Bay, Five

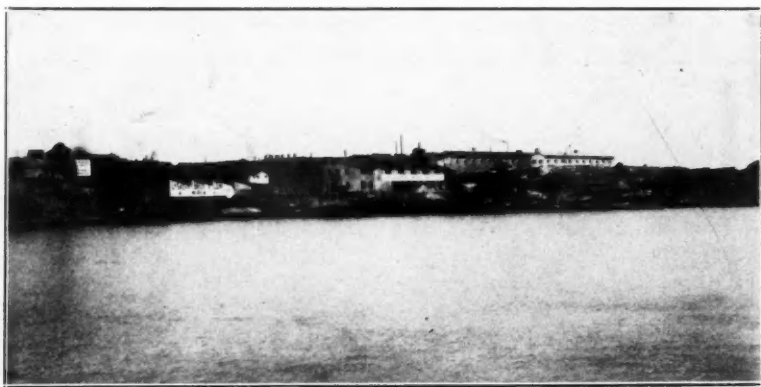


FIG. 19.—Extensive wire works situated on Fig Tree Bay (Drummoyne). The plant is built on the steep slope in order to have access to harbor shipping. The upland is fully occupied by workmen's residences.

Dock Bay, and most of Long Cove are too shallow for large boats and are devoid of industries.

On the northeast end of Concord Peninsula is the extensive gas manufacturing works which supplies fuel to most of the city area. The plant was established as early as 1884 when surrounding lands were largely devoted to orchards. Newcastle coal is brought to the plant by a fleet of colliers. By-product coke from the gas plant is an important industrial and

domestic fuel in Sydney and by-product tar is extensively used as a binder for road construction. Nearby is a large white-lead and paint manufacturing plant which receives pig lead by boat from the smelters at Port Pirie, South Australia.

The extensive, public-owned, Homebush abattoirs and associated stock sales yards are situated on the low margins of Homebush Bay. Livestock is assembled at the sales yards by railway and motor truck from all over the State. Butchers buy stock at the sales yards, deliver the animals to the abattoirs on the day prior to slaughtering, and pay a fixed sum per carcass for the services of the abattoir staff. The prepared meats are then delivered by highway truck to retail meat markets in all parts of the Sydney area. Export meats are shipped principally through Darling Harbor. Large abattoirs were situated on Glebe Island prior to the concentration of all slaughtering activities of the Sydney area at Homebush in 1916.

A number of industries, including large iron works, a pipe factory, flour mills, paint works, and lumber mills, are situated near the Rhyde Bridge narrows, where they have access to shipping by water and rail (Fig. 20).

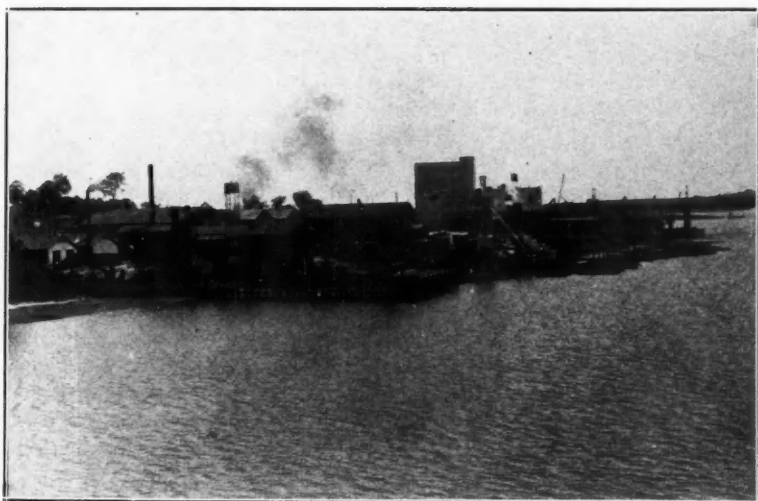


FIG. 20.—Saw mill at the Rhyde Bridge narrows along the Parramatta River. Grain elevators and other industries in the background are beside the railway. The reduced elevation of the inner harbor margins is indicated.

Numerous important industries are situated in Parramatta, some along the water front, and others along the railways. Among them are oil refining

plants, fertilizer works, asbestos, magnesite, kalsomine, and tile plants, chemical factories, a linseed oil mill, and a rubber tire plant. Large tracts of low-lying and unoccupied land along the narrow estuary channel to the east of Parramatta will undoubtedly attract other industries in the future.

Southern Manufacturing District

Two-thirds of the factories of New South Wales are concentrated in Sydney and they employ more than four-fifths of the workers and account for more than three-fourths of the value added to raw materials by manufacturing. Metal workshops and clothing factories give employment to much greater numbers of workers than any other groups. Food and drink factories, paper and printing establishments, textile mills, furniture and wood-working plants, chemical factories, brick and ceramic works, and leather industries follow in the order of their importance as employers of labor. Most raw materials as well as fuel must be introduced. The large consuming market and labor supply provided by the metropolitan population are important stimuli to local manufacturing. Costs of distributing manufactured goods to the large local market are relatively low. Important manufacturing enterprises have developed recently at Newcastle and at Port Kembla on important coal fields but they are concerned chiefly with bulky iron and steel production.

The principal manufacturing district in Sydney lies to the south of the central business core and the warehouse and shipping district associated with Darling Harbor. Many industries occur in old residential districts in the vicinity of the Central Railway Station but newer ones have spread southward upon the Alexandra Canal Lowlands in Waterloo, Alexandria, Mascot, St. Peters, and Marrickville (Fig. 1). While many of those municipalities might seem to be more intimately associated with Botany Bay, almost none of the industries look to that bay for outlet and only a few occur as far south as its shoreline. The entire industrial district has grown up in close relationship with the major urban development along the south margin of Port Jackson.

Scattered through old residential neighborhoods at the northern end of the industrial district are large breweries, manufacturing plants associated with retail department stores, and a wide variety of light manufacturing establishments which find close contact with the central city advantageous. Factories producing boots and shoes, clothing, printed material, furniture, foodstuffs, and light machinery, along with numerous warehouses have grown up in close proximity to the large Alexandria railway goods station. The important Eveleigh railway construction and repair shops, which have long occupied their position near the central city, are gradually being re-

placed by the newer Chullora Shops and marshalling yards in the open western suburbs (Fig. 1).

The Alexandra Canal lowland was earlier avoided by residential development because of flood danger and thus it provided a highly desirable tract near the central city for the many new manufacturing industries springing up in Sydney after the World War of 1914-1918. Industries occupy more or less solidly a tract of some two square miles in which the absence of intermingled homes forms a sharp contrast with the older industrial areas of Sydney. The plants are in excellent physical condition and of modern structural design (Fig. 21). The following types of commodities are manu-

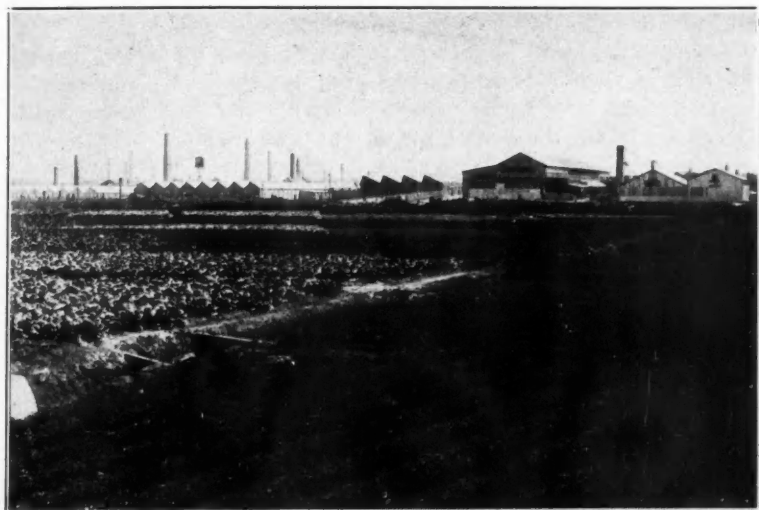


FIG. 21.—Many large industrial establishments occur in the Alexandra Canal lowland. Structural steel works (right) and spinning mills (left) are shown with the chimneys of brick works in the background. Truck farming is gradually being pushed to the south as more industries come to the area.

factured in large modern factories in the district—iron and steel products, machinery, textiles, furniture, electrical goods, glass, automobile accessories, and confectionery goods.¹⁷ Industries of less areal importance produce lubricants, paints, roofing materials, lime, shoes, bedding, matches, cooperage, and miscellaneous food products. In line with the recency of their

¹⁷ Detailed information about many of Sydney's larger industrial plants is available in: Pratt, Ambrose, and Leeson, Edward: *The National Handbook of Australia's Industries*, (Melbourne) 1934, pp. 99-218.

establishment most plants are entirely dependent on automobile transportation, on electrical power, and on gas for fuel.

Although the Alexandra Canal has been dredged for a distance of two miles above its junction with Cook's River little use is made of it, in part because of the shallow depths available through Botany Bay. Extensive mud flats and wet pasture land still border the lower canal route. A portion of that tract has been developed as a major air port at Mascot. Owing to the general ruggedness of the Sydney area airport location creates a considerable problem except on the more distant level areas to the west of Parramatta. Commercial truck gardens occupy tracts of the somewhat better drained lands along the canal route but they are being pushed steadily southward as industries invade the lowland from the north.

In the Marrickville portion of the Cook's River lowland is Sydney's principal textile manufacturing center (Fig. 1). Large woolen and cotton spinning, knitting, and weaving mills form a compact specialized industrial community along the line of the South Coast Railway. Metal manufacturing establishments of wide variety, pottery plants, and food preparation factories are other significant types. Adjacent uplands are occupied by workmen's residences.

A narrow shale ridge rising above the general lowland surface in St.



FIG. 22.—Group of brick and tile plants in St. Peters. Various grades of raw materials are available locally for the production of different clay products.

Peters provides the basis for a notable concentration of brick and tile manufacturing establishments (Fig. 22). The groups of tall square brick chimneys belching forth clouds of coal smoke provide one of the principal features of Sydney's industrial skyline. Gas is used as fuel in burning roofing tile and terra cotta products. Other large brick plants are scattered about the margins of the lowland and along the upper Cook's River, where clays and shales are easily quarried. The Mortdale and Sutherland district near the George's River crossing of the main line of the South Coast Railway also has important brick works. Still others are found in Parramatta and Homebush near the head of Sydney Harbor. In North Sydney large brick plants extract clay from deep pits in the shale-capped upland surface and they comprise the only important industrial development in the North Shore suburbs. Brick manufacture is especially significant in Sydney because of its widespread distribution and because brick is easily the most used building material.¹⁸

A wide variety of new and old industries has developed on the margin



FIG. 23.—Characteristic residence street in Botany, showing old-style wood houses with sheet-iron roofs. A conspicuous feature is the rolled veranda roofs with the iron sheets painted alternately red and white.

¹⁸ Even in the 1840's it was claimed that most houses in Sydney were constructed of bricks covered with plaster. Other houses were built of wood and stone. Hood, John: *Australia and the East*; (London) 1843, pp. 97-8.

of the slightly elevated and dune-covered district lying to the east of the Alexandra Canal lowland. Botany Road, which connects Sydney with Botany Bay and along which many old residences were located, is the principal axis of that development (Fig. 23).

In the vicinity of the Lachlan Swamps (Botany), where large quantities of soft water are available, extensive wool-scouring, fell-mongering, and tanning industries have long been in operation (Fig. 24). Many of the



FIG. 24.—A notable grouping of wool scouring plants occurs along Lord Street beside the Lachlan Swamps in Botany. Many smaller establishments are distributed widely along water courses in that vicinity.

smaller establishments are scattered through decadent residential districts and along small ditches through which waste water is discharged into Botany Bay (Fig. 25). Spent wattle bark from the tanneries serves to check drifting sand about many residences and it provides a cover for footpaths and roads throughout the neighborhood.

Shoe factories, soap and candle works, casing and glycerine plants, fertilizer and glue factories, gelatine works, and woolen mills are other industries engaged in the processing of animal products in that vicinity. Prior to the centralization of all slaughtering activities at Homebush, Botany Bay acquired prominence in the treatment of animal by-products. It was readily accessible to the former abattoirs at Glebe Island and to many of the

small slaughter houses in outlying suburbs. At that time Botany Bay, which was somewhat detached from the city, came to be regarded as the proper center for offensive industries of all kinds. The presence of the large city sewage farm at the mouth of Cook's River did not improve the district for residential purposes. Much effort is now expended in hauling hides, tallow, and other packing house products more than ten miles from Homebush to Botany through crowded city streets, but inertia tends to keep the establishments there. Other so-called offensive industries in the Botany Bay district include chemical and paint works, foundries and smelters, junk yards, and paper mills.

The most important industrial establishment actually fronting on Botany Bay is the large municipal Bunnerong electric power station (Fig. 1). Coal is delivered to the plant by rail principally from the western and southern coal fields. Some Newcastle coal is delivered by water to Darling Harbor and thence by rail to the Bunnerong station. If a short channel were dredged in Botany Bay coal could be delivered to the plant by direct water shipment from Newcastle and from Bulli. Water is drawn from Botany Bay for cooling purposes, thus giving some significance to the waterfront location. The branch freight railway from Marrickville was constructed

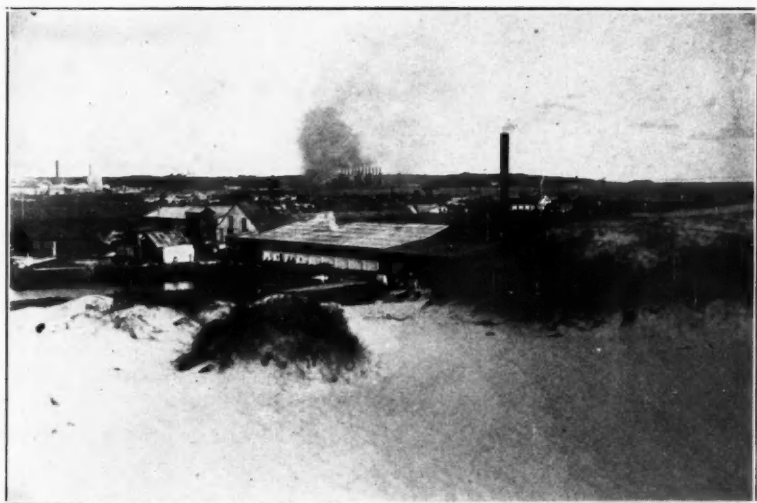


FIG. 25.—One of the many tanneries in the dune-covered Botany Bay district. The entrance to Botany Bay is shown in the distance at the right and the large Bunnerong power plant is shown on the bay's far margin (center).

specifically to serve the power plant along with any industries able to use a freight siding made available in Botany.

Eastern Residential Suburbs

The lands bordering the south side of Sydney Harbor, between South Head and Woolloomooloo Bay, are entirely devoted to residential and associated recreational uses (Fig. 6). A half dozen gracefully curved bays, separated from each other by upland spurs and fringed with sandy beaches varying from a small fraction of a mile to more than a mile in length, characterize that waterfront. Pleasure boats ride at anchor in the wider bays and all the beaches are reserved for public recreation as are also two small islands lying short distances off-shore (Fig. 26). Shady lawns border the



FIG. 26.—Southward across Watson's Bay, showing the type of residential development which borders the south side of Port Jackson. A wide beach fringes the head of the bay (left) and a pleasure-boat anchorage is available.

beaches and attractive public parks keep business establishments and transportation lines at a reasonable distance (Fig. 27). Areas for recreational purposes have been increased by extensive filling operations at the heads of Rushcutters, Double, and Rose bays.

The use of Watson's Bay, just inside the harbor entrance, for holding in-coming vessels for medical examination and as the center for harbor pilot

service represents the only approach to commercial use of that water front. The high ridge terminating in South Head gives excellent protection to vessels from southeasterly gales and the elevated north shore shelters vessels from strong land winds. Garden Island is one of the principal naval centers in Australia and the presence of several units of the fleet lying at anchor adds interest to that portion of the harbor. Sydney Harbor and its many scenic arms provide an endless source of pleasure for the many sailing enthusiasts.

Large estates occupy most of the high promontory surfaces while more modest residences cover the gentler slopes rising from the heads of the numerous bays (Fig. 28). Comfortable summer temperatures are an important advantage of the eastern suburbs. Wherever possible residences are so oriented as to capitalize the harbor views. Streets are commonly adjusted to slopes and effective landscaping and residential architecture are typical of the district. Apartment houses and residence hotels skirt the waterfront in places near the central city (Fig. 29) while small villas commonly occur adjacent to the beaches near South Head. The red tile roofs of brick and stucco homes emerging from the green lawns and ornamental trees covering the slopes, in association with the intense blue of the water, and the intervening light-colored beach fringe comprise the magnificent



FIG. 27.—The attractive character of Sydney's "inner" beaches (about the margins of the estuary) is illustrated by the head of Shark Bay. Grass-covered and shady parks occupy the entire lowland at the head of the bay.

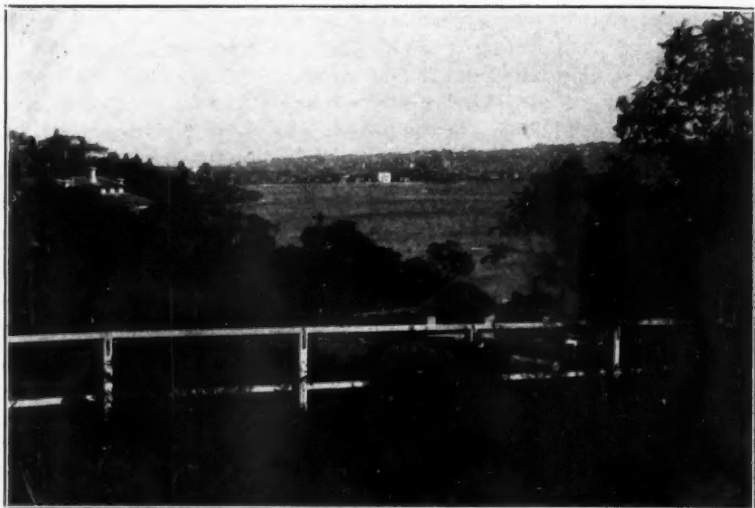


FIG. 28.—Rose Bay as seen from among the attractive estates in Vaucluse which fringe the southern harbor margins. Woollahra, another exclusive residential district, is shown across the bay.



approach to Sydney's wharves. With a scenic shoreline on the opposite side of the bay it is not difficult to understand why overseas visitors regard Port Jackson as one of the world's most attractive harbors.

The eastern suburbs enjoy close contact with the outer ocean front as well as with Port Jackson. Sandstone cliffs, 100-200 feet in height, prevent access to the ocean in many places but they provide excellent outlooks to sea for homes which occupy their margins. In places sandy beaches occur between rocky promontories and they are usually backed by gradually rising slopes which form extensive amphitheatres for residential development (Fig. 30). Waverly and Randwick are among Sydney's most rapidly

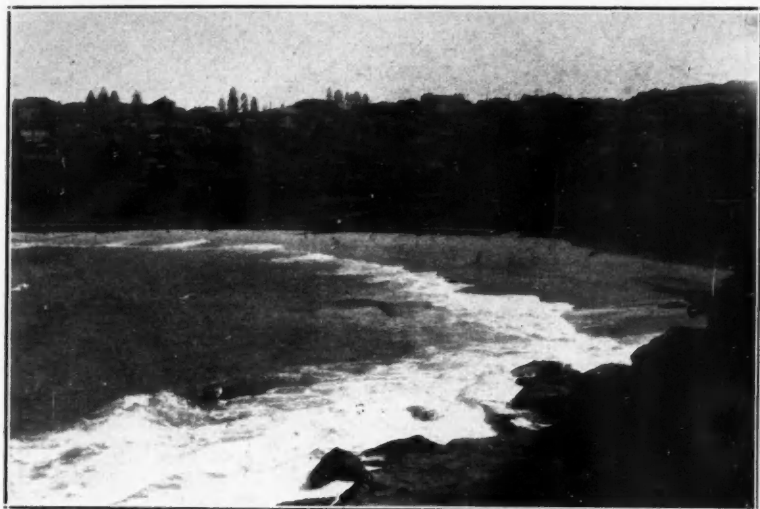


FIG. 30.—A view south along the ocean front at Bronte showing a characteristic surfing beach and the manner in which public park lands, commercial houses, and residences occupy successive levels on the slopes enclosing the bay.

growing suburbs. Surfing beaches at Bondi, Bronte, and Coogee are among Sydney's most popular recreation centers. Those beaches lie only four or five miles to the east of the central city and are easily accessible to great numbers by tram. The rapid recent growth of some eastern ocean front

FIG. 29.—Large modern apartment houses cover the slopes bordering Rushcutter's Bay. The central city is easily reached by tram, bus, private automobile, and ferry boat. A characteristic suburban ferry landing is shown.



FIG. 31.—Crowded new residential development in Waverly on the upland surface near Bondi Beach. The houses are constructed chiefly of brick and they have red tile roofs. Small lots, barren streets, and monotonous repetition of house designs are characteristic. The open ocean lies in the background.

suburbs has resulted in monotonous duplication of single and multiple brick residences over wide areas by speculative builders¹⁹ (Fig. 31).

The opportunity remains for extending the eastern suburban development southward along the ocean front almost to Botany Bay. Sandstone cliffs of moderate height border the entire sea front and an undulating surface mantled with dune sand extends for several miles inland. Not the least among the attractions of the dune area for residential development is the fact that cellars need not be excavated in solid rock as is characteristic in many parts of Sydney. Surfing beaches are available at intervals along the entire water front awaiting more intensive development and use.

North Shore Residential Suburbs

The north shore district is higher in elevation than the south shore of

¹⁹ The practice of naming private residences is characteristic throughout Australia whether or not street numbers are displayed. A well-polished brass name plate at the entrance identifies even the poorest house. Amazing mixtures of British, Australian, aboriginal, and other names are to be found in any neighborhood. A few names applied to homes situated along the ocean front between Bondi and Coogee bays show such variations as Pacific View, Seaforth, and Cliff Edge; Cowan Brae, Lang Syne, and Gaerloch Manor; Dungowan, Goorangai, and Beroya; Wyoming, Hollywood, and Sun Kist; Santiago, Waikiki, and Khartoum.

Port Jackson and it is deeply incised by Middle Harbor, Lane Cove River, and other streams which have cut back into the Hornsby Plateau (Fig. 6). Steep bluffs commonly face Port Jackson and the shoreline is usually rocky and difficult to approach. In consequence little use is made of the north shore for commerce and industry. Residential development, however, is readily carried out on the upland surfaces which are accessible to transportation lines (Fig. 32). The suburban railway extending from the central



FIG. 32.—Long Bay, like other branches of Middle Harbor, reaches far back into the North Sydney Upland. Precipitous and rocky slopes make access to the waterfront most difficult. Upland surfaces are generally devoted to residential uses.

city across the harbor bridge and northwest to Hornsby is of particular importance in encouraging residential expansion (Fig. 1). To a lesser degree suburbs have sprung up along the railway crossing the Parramatta River at the Rhyde Bridge narrows and also proceeding to Hornsby. Further notable development has taken place in Mosman along the north shore upland roadway to Manly on the ocean front. Approximately one-fifth of the metropolitan population of Sydney resides on the north shore.

In most parts the north shore residential development is separated from the waterfront by steep slopes which are commonly timbered and held as public reserves (Fig. 6). In the vicinity of the harbor bridge, however, where contact with the central city is especially easy, modern tall apartment buildings cover the gentler slopes leading down to the water's edge. Along Lane Cove River an unequalled degree of intimacy is attained between resi-

dential development and the littoral. The lower elevation of Hunter's Hill peninsula affords building sites with lawns sweeping down to the water's edge, along with private boat sheds and bathing enclosures hewn out of the rocky shoreline. Residents of that district are dependent for transportation on harbor ferries to an exceptional degree. Residential streets of Hunter's Hill are commonly bordered by high hedges and board fences to insure privacy for the many fine homes which invariably face the water margins. Such fences are characteristic in many parts of Sydney although they tend to be replaced by low hedges and wire fences in the newer suburbs (Fig. 33).



FIG. 33.—A secluded spot at the head of Glades Bay (Rhyde) where scattered homes have not caused the destruction of the original vegetation. Private boat sheds and shark-proof bathing enclosures are characteristic.

Aside from a small gas works to serve a portion of the northern suburbs and a few boat repair docks and oil storages (between Neutral Bay and Fern Bay) no important industries occur along the north shore waterfront. In the early years of commercial enterprise at Sydney a plant was situated on Mosman's Bay to which ship loads of reeking whale blubber were brought for rendering after which the oil was shipped to Europe. Recreation reserves occupy much of the north shoreline and pleasure boats are anchored in the many small coves. A few short stretches of sandy beach usually are to be found at the heads of the narrow bays. Public water reservations for Manly include extensive tracts along Middle Harbor and military reserves cover large areas near the entrance to Port Jackson.

Middle Harbor, penetrating deeply and intricately the thick layers of sandstone of the Hornsby Plateau, provides a landscape of steep cliffs rising from the water's edge and covered with a stunted eucalyptus forest. It is probably fairly representative of the original appearance of much of Port Jackson. Most of the waterfront is undeveloped although in a few places the upland residential pattern descends to take advantage of a bit of sandy beach or a protected anchorage (Fig. 34). Innumerable panoramic views



FIG. 34.—An attractive residential district on a gentle slope leading down to Middle Harbor in Mosman. Brick and stucco homes of this type with red tile roofs are representative of much of the north shore development.

are available from the upland margins of the intricately carved, drowned river system. Small vacation cottages cling to the steep slopes in places along the extensive waterfront. The few roads which penetrate the area follow the ridges which form the principal drainage boundaries.

North Harbor owes its development to the formation of a low sand spit connecting North Head with the mainland. Manly is the principal north shore recreation center and beach community (Fig. 35). The cove on the protected side of the sand spit and the long surfing beach on the ocean front afford a full range of recreational activities within a compact unit. The Spit bridge between Mosman and Manly provides the most convenient and direct connection with the ocean front for all the north shore residential suburbs located to the west of Middle Harbor (Fig. 6).



FIG. 35.—The outer beach at Manly looking south to the rocky mass of North Head. A public park planted with Norfolk Island pines borders the strand.

To the north of Manly for nearly twenty miles extends a succession of rocky promontories and sandy curved beaches terminating in the narrow peninsula forming the south head of Broken Bay (Figs. 1 and 3). The quiet Pitt Water arm of Broken Bay on the west side of the narrow peninsula doubles the attraction of the northern third of that frontage for recreational purposes. A steadily expanding road pattern makes the dune bordered surfing beaches, the old wharf communities on Pitt Water, and the timbered upland tracts readily available to people seeking a day's outing, or a site for a cabin or a permanent residence. Interrupting the recreational landscape are numbers of small farms which specialize in the production of tomatoes and other vegetables (grown under glass) for the Sydney market.

The Botany Bay District

Owing to the prominence of Botany Bay in the configuration of the Sydney area that body of water might be expected to play an important role in the life of the city. Field investigation shows that bay to have almost no importance commercially and industrially but to have considerable significance as a recreation center for the southern suburbs. Further description of Botany Bay's physical and cultural aspects will help also to emphasize by

contrast the outstanding advantages and importance of Port Jackson to Sydney.

The entrance to Botany Bay is nearly as wide as that to Port Jackson but it is not so deep (Fig. 1). The bay is directly exposed to easterly winds and strong wave action. A wide belt of high dunes behind Cronulla Beach connects the barren, rocky, south portal to the mainland. The north headland is formed by the southward continuation of the sandstone front which hems in Port Jackson. At Brighton a swampy and sandy lowland about a mile wide borders the western margin of the bay between the outlets of Cook's River and George's River. Important residential development has long occupied the adjacent upland surface in Rockdale. The north margin of the bay is bordered by a dune-covered, undulating lowland which extends about five miles inland or more than two-thirds of the way toward Port Jackson.²⁰ Some relatively high dunes, a few of which are active, fringe portions of the bay margin. Farther inland are some of the city's most extensive parks and recreation grounds including Moore Park, Centennial Park, and Sydney Common (Fig. 6). The Lachlan Swamps, which served for years as Sydney's main source of drinking water, drain a large portion of the dune area. The town of Botany which fronts on the bay margin is one of Sydney's older satellite suburbs.

Botany Bay takes no part in the port activities of Sydney. No wharves are available for vessels and only occasionally are shallow draft barges laden with coal, oil, or rock towed across the bay for delivery to several industries tributary to Cook's River. Small market fishing boats appear regularly in Botany Bay and there are important oyster beds along George's River and in sheltered indentations along the south margin of the bay. Pleasure boats cruise the bay waters and explore the intricacies of George's River on holidays. Although the Bunnerong power station at the northeast corner of the bay produces large quantities of smoke no civic nuisance results in that sparsely occupied district.

Botany Bay, however, contributes effectively to the recreational needs of the succession of suburbs which extend as far south as Port Hacking along the line of the South Coast Railway and Princes Highway. Several miles of protected beach are available along the west margin of Botany Bay and nearly as much occurs along the ocean front between the entrances to Botany Bay and Port Hacking. Several sports grounds are located on the flats bordering the bay on the west. The National Park Reserve on the south margin of Port Hacking is another major recreational attraction (Fig. 1).

²⁰ Halligan, G. H.: "The Physiography of Botany Bay"; *Jour. & Proc. Royal Soc. of N. S. W.*, Vol. 47 (1913), pp. 120-9.

Despite the sterile character of most of the soils in the vicinity of Botany Bay the district is one of the important sources of fresh vegetables for the Sydney market. Vegetable farming is almost entirely in the hands of Chinese whose inherent patience and skill help to compensate for the infertility of the soils.

A large tract of land at the mouth of Cook's River long served as a sewage farm before the southern outfall was extended to the ocean front just north of La Perouse. Those portions of the city bordering Port Jackson are served by outfalls which deliver the effluent to the ocean front at Manly and at Bondi. The raw sewage is promptly diluted and swept off-shore by deep, southerly-moving currents. It is worth noting that until the 1880's sewage was dumped into various arms of Port Jackson adjoining the central city. With the large growth of the city that practice became intolerable.

WATER AND POWER SUPPLIES

The account of Sydney's successive moves to obtain an adequate water supply is of considerable geographic interest. Although Tank Stream was Sydney's principal source of water for a number of years its small runoff soon proved inadequate and pollution of the supply was inevitable. By 1837, water from a marshy area at Centennial Park ($2\frac{1}{2}$ miles southeast of the city) was delivered to a reservoir in Hyde Park and it provided adequately for the 2,000 persons then living in Sydney. By 1849, population had doubled and a severe drought caused the city to search for additional supplies. A project was completed in 1858 in the Lachlan Marshes which drained seven square miles of swampy and dune-covered land north of Botany Bay. A series of small dams along the poorly defined creek helped to increase the storage (Fig. 1).

Continued growth of the city and recurring droughts led to the appointment of a Royal Commission in 1867 to report upon the possibilities of securing an adequate water supply. A plan was finally adopted for the development of the upper Nepean River watershed, 40 miles south of Sydney, but the initial unit was not completed until 1887. The large Prospect Reservoir was constructed 20 miles to the west of Sydney for storage purposes in preference to reservoirs on the catchment area. An aqueduct forty miles in length connected Prospect Reservoir with the watershed area. With continued growth of the city, it was necessary to construct large storage reservoirs on successive units of the watershed in order to conserve flood runoff (Fig. 3).

The catchment now developed on the upper Nepean River has an area of 347 square miles, and it may readily be increased to 400 square miles. The area is an excellent watershed because it receives annually 50-60 inches

of well-distributed rainfall, the underlying sandstone and volcanic rock are highly absorbent, and the upland (2,000 feet above sea level) is timbered and without inhabitants. The amount of water drawn from the catchment annually is 30-35 billion gallons and a population of 1,400,000 is served. Filtering and chlorination are not necessary due to the favorable character of the watershed. In addition to all of metropolitan Sydney, water is supplied to several towns along the aqueduct and to Port Kembla, Wollongong, and other towns on the South Coast Coal Field.²¹

Owing to the great diversity of relief in Sydney many distributing reservoirs (usually placed on prominent hills and ridge tops) are necessary to give satisfactory service. Only a third of the water consumed can be delivered by gravity from Prospect Reservoir. Per capita daily consumption averages about 65 gallons and consumption in mid-summer is about fifty per cent greater than in winter.

Just as important as the water supply of any great city is its supply of electricity. The Bunnerong power plant of the Sydney County Council is the largest producer of electricity in New South Wales and it serves an area of about 900 square miles and a population of over a million. About 1,000 tons of coal are consumed daily. Fresh water for the boilers is purchased from the metropolitan supply. Power is delivered to the central city by underground transmission lines, thus avoiding unsightly surface structures. The annual electricity output amounts to about 500 million kilowatt hours. A small, older, power plant at the head of Darling Harbor is now used only as a standby in connection with the Botany Bay plant.²²

LARGER ASPECTS OF SYDNEY'S LOCATION AND SITE

Sydney owes its first rank among the cities of Australia in part to its favorable maritime position. Not only is Port Jackson midway between the ports of Queensland on the north and those of Victoria, South Australia, and Tasmania on the south, but it is the most convenient mainland port in relation to the principal trade centers of New Zealand. In similar manner Sydney is the most practicable Australian port for trade across the Pacific with the United States and Canada, and with Europe via the Panama Canal. Much of the South Pacific island trade also focuses upon Sydney, in part because of the obstructive influence of the Barrier Reef upon many Queensland ports. Sydney is almost as accessible to trade with Europe across the

²¹ Roseby, T. J.: *Sydney's Water Supply and Sewerage, 1788-1918*, (Sydney) 1918, 112 pp.; and *47th Annual Report of the Metropolitan Water, Sewerage, and Drainage Board* (1935).

²² Annual Reports of the General Manager of the Sydney County Council.

Indian Ocean as Melbourne and Adelaide. By reason of its strategic maritime situation Sydney is the outstanding entrepôt port of the continent.

Port Jackson is highly satisfactory as a harbor when compared from several viewpoints with other likely indentations along the New South Wales coast. It affords ample space and protection for the largest ships without costly improvements. Its varied shoreline is attractive in many respects to residential development and recreation as well as to commerce and industry. Much space is available for further growth of the city along many miles of undeveloped waterfront.

The site of Sydney is not without handicaps for a great city. The deep penetration of the site by the intricately outlined estuary and the rugged character of bordering lands are not helpful in the designing of an efficient city pattern nor highly favorable to the most economical functioning of a great metropolitan center. The environs of Sydney are notably lacking in fertile agricultural lands sufficient in extent for victualing a large city. Even the bulk of perishable food supplies, such as milk, vegetables, and fruits, must be hauled distances considerably greater than 100 miles. Instead of being bordered by belts of productive lands, as are many well-situated cities, Sydney is bordered by a wide belt of unproductive and little inhabited "bush."

Sydney's difficult direct contact with the extensive and productive interior of New South Wales is another of the obvious deficiencies of the site. With some resemblance to Rio de Janeiro Sydney has been characterized as "the superb gateway of a rugged and difficult hinterland."²³ The high plateaus, which parallel the entire coast of New South Wales, interpose a barrier between most points on the seaboard and the interior plains. The problem is to connect the best harbor along the coast with the interior through one or both of the broad gaps separating the northern (New England Plateau), central (Blue Mountain Plateau), and southern (Kosciusko Plateau) portions of the highland.

The Western Railway from Sydney is forced to climb 3,500 feet within a distance of fifty miles beyond the foot of the Blue Mountain front (Fig. 3). In contrast the present railway to the interior from Newcastle attains an elevation of only 2,073 feet over the Liverpool Range. When the route through the Cassilis depression, via the Hunter and Goulburn river valleys, is completed an elevation of only about 1,500 feet will need to be attained in crossing the Great Dividing Range.

With the additional 100-mile haul from Newcastle, Sydney also has contact with the northern interior plains over the same favorable routes avail-

²³ Auroousseau, M.: "Sydney—A New Interpretation"; *Sydney Morning Herald*, December 27, 1924, p. 5.

able to Newcastle. There is good opportunity for shortening that distance by developing another feasible railway route to the north from Sydney.

In similar manner Sydney has access to the southern interior plains of New South Wales over the main Southern Railway which crosses the divide near Goulburn at an elevation of about 2,400 feet. If the southern interior of the State alone is to be tapped, it is conceivable that Jervis Bay, despite its exposed character, might serve as the logical outlet (Fig. 3). No railway, however, reaches Port Jervis at present despite hopes for such construction.

Thus while Sydney lacks an easy and direct western route to the interior it actually has three important railway routes to tap the northern, central, and southern portions of the interior plains. Its central position along the New South Wales coast gives it advantage over other likely ports in reaching *all* portions of the interior. It is also claimed that the railway route across the Blue Mountain Plateau could be improved by utilizing the gradient along Cox's River rather than the ridge which marks its northern drainage limit.

Since it is asserted by some that Newcastle occupies a better site for a great city than Sydney it should be pointed out that it too is backed by large expanses of unproductive, uncleared, and rugged sandstone country. While the Hunter River Valley affords some excellent, close-in farm land, large parts of the lowland are marshy and subject to flood. Flat land available for urban or agricultural uses is actually more limited than in the vicinity of Sydney. The river harbor and local site at Newcastle are unquestionably much less adequate for extensive urban development than Port Jackson and its environs.²⁴

The presence of much excellent coal has logically encouraged important industrial development at Newcastle. Similar development has taken place at Port Kembla on the South Coast coal field. The Western coal field at Lithgow is only 100 miles from Sydney on the Blue Mountain Plateau and it too has attracted population and some industry. Those three centers may be regarded as industrial satellites of Sydney and their growth is inextricably interwoven with that of the metropolis.

Although the State of New South Wales is enclosed by highly artificial boundary lines most of the State is commercially tributary to Sydney. Only the extreme north, west, and south margins are more closely tied to Brisbane, Adelaide, and Melbourne. The extensive State-owned railway system which clearly focuses upon Sydney has been a major factor in binding the

²⁴ Zierer, C. M.: "Industrial Area of Newcastle, Australia"; *Econ. Geog.*, Vol. 17 (1941), pp. 31-49; and "The Australian Iron and Steel Industry as a Functional Unit"; *Geog. Rev.*, Vol. 30 (1940), pp. 649-659.

hinterland of the richest Australian State to the capital city and its harbor. In that situation lies the principal explanation of the fact that Sydney has attained a population of one and a quarter million persons or nearly one-fifth the population of the entire continent.

University of California at Los Angeles.

May, 1941.

Colonel Claude Hale Birdseye

R. H. SARGENT

Col. Claude Hale Birdseye, one of the most widely known engineers in the country, and a former President of the Association of American Geographers, died at Mount Alto Veterans Hospital on May 30, 1941. At the time of his death he was Chief of the Division of Engraving and Printing of the United States Geological Survey, which position he had held since August 1, 1932.

Col. Birdseye, former Chief Topographic Engineer of the United States Geological Survey, a distinguished soldier in the first World War, an eminent photogrammetrist, and leader of a daring exploration through the Grand Canyon of the Colorado River, leaves behind him a life crowned with high achievements.

He was born in Syracuse, N. Y., on February 13, 1878, the son of George Frederick Hurd Birdseye and Katherine Lamb Birdseye. Later the family moved to Oberlin, Ohio, and in June 1895, young Birdseye was graduated from the High School of that place. He entered Oberlin Academy the following year and later Oberlin College, from which he was graduated in 1901, receiving the degree of Bachelor of Arts. He did post-graduate work at the University of Cincinnati and Ohio State University, Columbus, Ohio. For a time he was instructor in physics at the University of Cincinnati.

In 1931 Oberlin College recognized his achievements of the past thirty years by conferring upon him the honorary degree of Doctor of Science. Col. Birdseye's modesty prevented all but a very few of his closest friends from knowing of his honor.

The most of Birdseye's post-college life was in connection with the Geological Survey. On October 19, 1904, he was appointed topographic aide, classified in the Federal Civil Service for permanent employment in the Geological Survey. Only a month later he returned to Oberlin to marry his boyhood sweetheart, Grace Gardner Whitney, on November 21, 1904. Thus Col. Birdseye began almost simultaneously his domestic and professional careers.

From the very first he exhibited characteristics and qualities by which his associates and his chief recognized him as a potential leader. As early as 1907, when his services were sought for work in Alaska and he was willing



COLONEL CLAUDE H. BIRDSEYE, 1878-1941

to accept the position, his chief said of him to the head of the topographic work in Alaska: "You do not want to take Birdseye for, first, he will take your job away from you, and second, he is a coming geographer (Chief of Division) and to take him to Alaska will retard and perhaps jeopardize his chances."

He developed rapidly because of his deep interest, not only in his work at hand but also in his desire to explore all avenues which might lead to improvement in the art of mapping. In 1907-1908 he was assigned to the General Land Office for some special work. From 1909 to 1912 he was in charge of topographic mapping in Hawaii, during which time he mapped the active volcano, Kilauea, with its lake of fire. In 1913 he returned to the States and supervised the mapping of the Mount Rainier, Wash., quadrangle.

In January 1916 Col. Birdseye was appointed geographer in charge of all topographic mapping by the Geological Survey in its Rocky Mountain Division.

He volunteered in the World War and was called into active military service on June 18, 1917, as a Captain of Engineers, and a few weeks later was promoted to the rank of Major. He sailed for France on August 16, 1917, for duty as Orienteur Officer with the First Brigade of Coast Artillery. Here he applied his knowledge of surveys and observations in the technique of aiming the big guns. A year later he was promoted to the rank of Lieutenant-Colonel and assigned to the Office of the Chief of Coast Artillery, American Expeditionary Forces, in charge of artillery ranging and map information.¹ In 1919 there was conferred upon him the French Order of University Palms, grade of Officier de l'Instruction Publique, in recognition of his achievements. Col. Birdseye's ability and readiness to cope with emergencies, and his power to command, gained for him these assignments and recognitions and resulted in valuable service to his country during the first World War.

After the war he obtained his discharge, retaining a reserve officer's commission as Lieutenant-Colonel.

He returned to the Geological Survey and on October 1, 1919, he was appointed Chief Topographic Engineer. The evaluation of his ability and his future, as made by his chief in 1907, was thereby fulfilled. Col. Birdseye's outstanding achievements, both in the line of engineering and in exploration, were accomplished after he became Chief Topographic Engineer. The harnessing of the turbulent waters of the Colorado River by the ultimate

¹ "Meridian Determination," Pt. III of Orientation for Coast Artillery, Coast Artillery Training Center, Fort Monroe, Va., 1919; also Appendix I to Pt. III, "Ephemeris of the Sun and Stars," and Appendix II to Pt. III, "Circumpolar Ephemeris."

building of the Boulder Dam required first a detailed knowledge of the upstream stretches of the river. A request for a survey of these difficult areas came to the Geological Survey. Birdseye could have detailed some topographic engineer under his command to bear the responsibility of this mission, but partly because he was enthused by the thrill of exploration, and partly because he knew it was a hazardous undertaking, he chose to head the expedition himself.

In August, 1923, he, with a staff of ten, including engineers and boatmen, set out in 18-foot boats especially constructed for the purpose to make an engineering survey of some of the wildest waters in the world, from Lees Ferry, Ariz., to Needles, Calif.^{2,3} Major Wesley Powell was the explorer of this region in 1869 and 1871.

In two and one-half months the party covered approximately 500 miles of turbulent river. Shooting rapids, portaging around waterfalls, and climbing the steep slopes of the canyon to keep from being drowned by the rising flood waters were arduous enough; but in addition to all of these a continuous survey and mapping of the river and canyon was executed. True it is that much of the credit belongs to the men who assisted the Colonel, and he never failed to give them full credit, but his choice of men and his boundless energy, enthusiasm, and power to command by leading, made the expedition a marked success.

For his contributions in the field of geography and exploration, of which the Grand Canyon trip was outstanding, Col. Birdseye was awarded the Charles P. Daly Medal of the American Geographical Society of New York on April 22, 1924.⁴

About this time the art of mapping was entering a new and critical period. The use of aeroplanes and aerial photography, which had developed so rapidly during the war, was beginning to alter the technique of mapping through the introduction of photogrammetric methods. Because of his deep interest in the use of the aerial camera in mapping, his constant study of the matter, and his administrative ability, he soon became one of the foremost photogrammetrists in the United States. He was one of the leaders in organizing the American Society of Photogrammetry, of which society he became the first president and in which he sustained a keen interest to the end of his active life.

² "A Boat Voyage through the Grand Canyon of the Colorado," by Claude H. Birdseye, and Raymond C. Moore, *The Geographical Review*, Vol. XIV, No. 2, April, 1924.

³ "Surveying the Grand Canyon of the Colorado," by Lewis R. Freeman, *National Geographic Magazine*, May, 1924.

⁴ *The Geographical Review*, Vol. XIV, No. 3, July, 1924, p. 465.

Col. Birdseye was a man of dynamic energy, always interested in all phases of engineering, surveying, and mapping, particularly in advancing the art in the Federal Government.⁵ He worked tirelessly and wrote assiduously in connection with his society and committee membership.

In September, 1929, he resigned from the Geological Survey to become president of the Aerotopograph Corporation of America. This company made a detailed photogrammetric survey of the site of Hoover (Boulder) Dam under his direction.^{6, 7}

On February 1, 1932, Col. Birdseye returned to the Geological Survey as engineering assistant to the Director. A few months later he was made Chief of the Division of Engraving and Printing, where he was in charge of the reproduction of the maps published by the Survey. He threw himself as keenly into the work of reproducing the maps which had been made under his supervision as he had into the making of them. Meanwhile his interest in the larger fields of surveying, mapping, and photogrammetry continued.⁸

Col. Birdseye was the first executive secretary of the Federal Board of Surveys and Maps, in which capacity he served until 1924. On January 12, 1926, he was elected chairman of the Board, and was again elected to that office in 1927. During the remainder of his life he was continuously either the Geological Survey representative or a member of the advisory council of the Board, representing the Association of American Geographers. He was chairman of some of its most important committees and essentially the author of several of its most valuable reports, among which was the report on a "National Mapping Plan" proposed by the Federal Board of Surveys and Maps in November, 1934.⁹ His committee also prepared a further report on the same subject which was adopted by the Board on December 8, 1936. These reports were reviewed by the Secretary of the Interior in a letter addressed to Congress on January 28, 1937,¹⁰ in which he urged that the mapping of the United States be accelerated.

Col. Birdseye had many irons in the fire but he always kept all of them red hot. In addition to his official duties he was very active in delivering lectures and in writing papers on subjects¹¹ dealing with map making.

⁵ *Transactions, Am. Soc. C. E.*, Vol. 92 (1928), p. 1486.

⁶ "Photographic Surveys of Hoover Dam Site," by C. H. Birdseye, *Civil Engineering*, Vol. 1, No. 7, April, 1931, p. 619.

⁷ "Aerial Stereo-Photographic Mapping Instruments and Methods," by C. H. Birdseye, *Journal of the Optical Society of America*, March, 1932.

⁸ "Stereo-Topographic Mapping," by C. H. Birdseye, *Transactions, Am. Soc. C. E.*, Vol. 98 (1933), p. 771.

⁹ "The National Mapping Plan," *Civil Engineering*, Vol. 5, No. 2, February, 1935, p. 125.

¹⁰ "Topographic Mapping of the United States," *S. Doc. No. 14, 75th Cong., 1st Session*.

Col. Birdseye had been president of the Washington Society of Engineers and was very active in the work of the society.

He was one of the technical advisers who prepared the "Standard Specifications for Aerial Photography for General Map Work and Land Studies" for the Procurement Division of the Treasury Department. These specifications have been of great value and assistance in drafting contracts for the great amount of aerial photography used by the different Federal agencies.

On April 30, 1938, he was commissioned Colonel in the Engineer Corps, U. S. Army Reserve, advancing from the rank of Lieutenant-Colonel, held since his discharge from active military service. This promotion was initiated by the War Department, without the knowledge of Col. Birdseye, in recognition of his untiring labors and his increasing prominence in a field of engineering that is so important in time of war.

He also interested himself in the broader phases of geography. In June 1938, Col. Birdseye, ever seeking for improvement and advancement in the work of the Survey, went to Europe to study methods used there in the reproduction of maps. He attended the International Geographical Congress at Amsterdam, the Netherlands, and had hoped to attend the Congress of the International Society of Photogrammetry at Rome, Italy, but he was forced by ill health to curtail his trip and did not attend the conference in Rome. He did, however, bring back much valuable information.

From this time on Col. Birdseye's health was undermined but he pushed steadily onward. Those who knew him best marveled at his tenacity and viewed his physical condition with trepidation. He was far from a well man when the Association of American Geographers elected him president and he accepted the honor with many misgivings as to his ability to carry through. His presidential address delivered before the Association at Chicago in 1939 was of outstanding interest in the field of photogrammetry.¹²

Col. Birdseye was a valued and active member of the following organizations:

- American Society of Civil Engineers
- Washington Society of Engineers (President, 1938; Director, 1920-1921, 1929-1930, 1939-1940)
- Washington Academy of Sciences
- National Research Council, Division of Geology and Geography
- American Geophysical Union
- Society of American Military Engineers (Treasurer, 1929 and 1935)
- American Geographical Society (Fellow)

¹¹ "Plotting Maps from Aerial Photographs," by C. H. Birdseye, *Engineering and Mining Journal*, Vol. 136, No. 11, November, 1935.

¹² "Stereoscopic Photographic Mapping," by C. H. Birdseye, *Annals of the Association of American Geographers*, Vol. XXX, No. 1, March, 1940.

Association of American Geographers (President, 1939)
American Society of Photogrammetry (a founder; first President, 1933-1934)
American Engineering Council
Federal Board of Surveys and Maps (Secretary, 1920-1924; Chairman, 1926-1927)
Canadian Institute of Surveying
International Geographical Union (Vice President, 1938)
National Geographic Society
Royal Geographical Society (Fellow)
International Society of Photogrammetry
American Legion (Maryland, Post No. 105)
Cosmos Club, Washington, D. C.
Explorers' Club, New York, N. Y.
Kappa Sigma Fraternity

The actual contributions of this great man to engineering, geography, and photogrammetry are not the entire achievements of his life. To know and work with Col. Birdseye was an inspiration. He put his whole heart and soul into whatever he undertook. He was always tolerant of others' views; yet frank and fearless, although always friendly, in discussing a subject on which he might differ with others in opinion. His outstanding talents and unswerving devotion to duty have left the indelible stamp of his genius upon every phase of its activity; while by friendly counsel and assistance he was able to inspire many with enthusiasm for greater attainments. The powerful effect of his career will long continue to enrich the career of others.

He was survived by his widow, Grace Gardner Whitney Birdseye, his three children, Charles, Frederick, and Florence Birdseye, his mother Katherine Lamb Birdseye (since deceased), two sisters, Miss Bessie Birdseye and Mrs. Ellen (Birdseye) Hatch, and a brother, Sidney Birdseye.

United States Geological Survey
April, 1942

A NOTE: Suggestions for Illustrating Books

J. RUSSELL SMITH

(a) *Numbering illustrations:*

It is a rare occurrence when a human thinks up something new. We have had an age-long struggle with transportation, but the wheel and axle have been invented only once. We have made many kinds of picture writing, but only one alphabet.

In most things we follow the ruts of our ancestors with little thought about the rut.

As an example of this I submit myself, as Exhibit A. I have thoughtlessly followed my elders and numbered the illustrations in books thus—1, 2, 3, etc. As a result, Figure 49 was on Page 243, and when I referred to Fig. 49 it took the reader several seconds to hunt back and forth until he found the hidden objective. I had stupidly wasted the reader's time to no good purpose whatever. It was indeed worse than that—I often missed my objective. Who has not declined to hunt for an illustration because it was a hunt?

If I had referred to the page on which the illustration occurred it could have been found in one-fourth of the time with no loss to anyone.

Consider these facts and you will do two things: (1) be lenient in your judgments of primitive peoples for their apparent stupidity; (2) put the illustrations in your next book in the most easily findable manner by referring to the page on which the illustration is to be found.

(b) *The relative accuracy of different types of graphs:*

A graph is intended to make us realize, through our eyes, comparisons of number, size or volume. This concept is arithmetic, 1, 2, 3, 4, 5—not geometric, 1, 2, 4, 8, 16, 32; not on squares, 1, 4, 9, 16, 25; and not on cubes, 1, 8, 27, 64, 125.

Since the size or volume we try to show by graphs advances arithmetically, our graphs must vary arithmetically, not by squares or cubes.

The old bar graph is therefore correct, but the pictograph does it much more effectively by getting a more direct appeal to the eye, and it does not leave us guessing as to the ratio of the bars to each other. This is very far indeed from the recent style of showing relative numbers by the comparative volume of spheres—a method which is almost the same as cubes. It is bad.

unmitigatedly bad. It compounds the confusion that lies in using the comparative areas of squares. Comparing the area of squares is not quite so bad as comparing the area of circles. A comparison of sphere and bar showing the same data (Negroes in New York City) can be found in plate IVA, map C, in *Migration and Economic Opportunity*, by Carter Goodrich, and in *North America*, by J. Russell Smith and M. Ogden Phillips, page 149.

Columbia University.

January, 1942.

The subjoined item is published at the request of the American Library Association in the interest of periodicals such as the *ANNALS*.—Ed.

CONSERVATION OF SCHOLARLY JOURNALS

The American Library Association created this last year the Committee on Aid to Libraries in War Areas, headed by John R. Russell, the Librarian of the University of Rochester. The Committee is faced with numerous serious problems and hopes that American scholars and scientists will be of considerable aid in the solution of one of these problems.

One of the most difficult tasks in library reconstruction after the first World War was that of completing foreign institutional sets of American scholarly, scientific, and technical periodicals. The attempt to avoid a duplication of that situation is now the concern of the Committee.

Many sets of journals will be broken by the financial inability of the institutions to renew subscriptions. As far as possible they will be completed from a stock of periodicals being purchased by the Committee. Many more will have been broken through mail difficulties and loss of shipments, while still other sets will have disappeared in the destruction of libraries. The size of the eventual demand is impossible to estimate, but requests received by the Committee already give evidence that it will be enormous.

With an imminent paper shortage attempts are being made to collect old periodicals for pulp. Fearing this possible reduction in the already limited supply of scholarly and scientific journals, the Committee hopes to enlist the cooperation of subscribers to this journal in preventing the sacrifice of this type of material to the pulp demand. It is scarcely necessary to mention the appreciation of foreign institutions and scholars for this activity.

Questions concerning the project or concerning the value of particular periodicals to the project should be directed to Wayne M. Hartwell, Executive Assistant to the Committee on Aid to Libraries in War Areas, Rush Rhees Library, University of Rochester, Rochester, New York.

